ACRP

REPORT 82

AIRPORT
COOPERATIVE
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PROGRAM

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Preparing Peak Period and Operational Profiles—Guidebook

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 82

Preparing Peak Period and Operational Profiles—Guidebook

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), Airlines for America (A4A), and the Airport Consultants Council (ACC) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

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FOREWORD

By Lawrence D. Goldstein
Staff Officer
Transportation Research Board

ACRP Report 82 combines a guidebook with an accompanying interactive CD-ROM that provides airport planners with a set of tools (the "toolbox") that can be used to convert annual airport activity forecasts into forecasts of daily or hourly peak period activity. The toolbox contains two separate modules to address the flow of airport operations as well as passengers. The operations module allows users to estimate current and future design day aircraft operation levels based on user-defined design day parameters. This module further enables users to estimate current and future hourly operations as well as peak period profiles, with and without peak spreading. Similarly, the passenger module allows users to estimate current and future design day passenger levels, again based on user-defined design day parameters. In addition, this application allows users to estimate current and future hourly as well as peak-period passenger profiles, also with and without peak spreading, based on user-defined design day parameters. The passenger module also provides an option for modifying hourly profiles with lead and lag factors to assess the impact of passenger flows on passenger processing facilities throughout an airport. The guidebook provides step-by-step instructions for application of the toolbox, with definition of input components and direction for preparing initial estimates, identification of sources of required information, and specific guidelines on how to address various planning problems and issues.

The target audience for this guidebook and the accompanying toolbox is airport planners and designers, their consultants, and anyone else involved in planning airport airfield, terminal, and landside facilities. Specifically, the tools are designed to scope planning issues and facility requirements, to tailor facility requirements to specific levels of service, and to run multiple scenarios to address uncertainty. A final report documenting the entire research effort is also available as *ACRP WOD 14*.

The need for this guidebook grew out of a recognized industry desire to improve current aviation forecasting procedures applied to airport facility planning, increasing an ability to address complex interactive planning conditions. Forecasts of annual aviation activity, including the FAA's Terminal Area Forecasts (TAFs), are widely available and commonly used as the basis for aviation planning and environmental analyses at commercial airports; however, comparable forecasts of hourly or daily aviation activity that are required to plan and analyze aircraft movements and passenger flows, to program terminal building and other airport facilities, and to support environmental studies and remediation needs are not readily available.

Important findings of the research include the following:

- The average day peak month metric can lead to very different results depending on the degree of seasonality at an airport;

- For most facility requirements, the appropriate peak period metric is less than 1 hour;
- The difference between peak and off-peak load factors is declining as airlines use increasingly sophisticated yield management techniques to fill empty seats;
- There appears to be a correlation between the percentage of night-time operations and the strength of the economy; and
- Lead times (the intervals between the time passengers arrive at the airport and the time they board an aircraft) can vary significantly depending on the airport, the time of day, and security policies.

Addressing these findings, this guidebook and accompanying toolbox allow users to test alternative strategies as a function of changing conditions, with important ramifications for both short- and long-term facility planning and design.

CONTENTS

CHAPTER 1

Introduction and Overview

This chapter introduces peak period and operational profiles, describes the Guidebook's organization, and summarizes the features of the associated Toolbox.

The intent of this Guidebook is help airport planners to 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 Guidebook 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 does not require extensive forecasting experience, but some familiarity with airports and the airport planning process is assumed.

This Guidebook demonstrates how to quickly and effectively 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 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.

This Guidebook and the associated analytical 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 without incurring the cost of building for the single busiest time of the year.

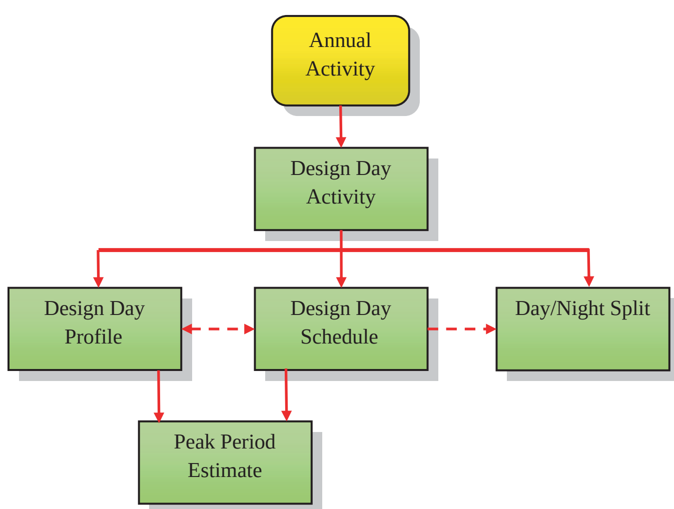
A peak period is an interval of time that represents the typical busy flow of passengers or aircraft operations that must be accommodated by an airport facility.

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.

An operational profile represents the distribution of arriving or departing passengers or aircraft operations by time of day during a selected day.

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. Exhibit 1.1 shows the relationships between annual activity, design day activity, the three types of operational profiles, and peak period activity.

Exhibit 1.1. Relationship between annual activity, design day, operational profiles, and peak period.



1.2 Background and Purpose of the Guidelines

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 widely 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 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 this Guidebook 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.

1.3 Structure and Organization

Guidebook and Toolbox users are anticipated to have a wide variety of backgrounds and needs. Therefore, to the extent possible, this document has a modular organization. The document is organized to allow quick navigation to the area of interest. Those interested in additional information regarding the recommendations and methodologies in the Guidebook and Toolbox are encouraged to read the accompanying report, *ACRP WOD 14: Guidelines for Preparing Peak Period and Operational Profiles: Final Report* (Project 03-12).

The chapters in this Guidebook are organized as follows:

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

Chapter 3: How to Use Guidebook and Toolbox provides guidance on identifying the appropriate forecasting tools for analyzing planning and environmental problems, depending on the specific issue and the level of detail required or possible. It also describes available default factors, the capability of generating multiple scenarios, and the identification of key variables. The limits of the Guidebook and Toolbox are also addressed.

Chapter 4: Preparation of Design Day Forecasts shows how to use the Toolbox to define and estimate the design day from current or forecast annual data. The chapter includes sample problems and provides some comments and cautions on the use of the data.

Chapter 5: Preparation of Design Day Profiles discusses how to use the Toolbox to calculate existing design day profiles of aircraft operations and passengers, and provides guidance for estimating future profiles. The chapter includes sample problems and provides some comments and cautions on the use of the data.

Chapter 6: Preparation of Design Day Flight Schedules provides guidance on the preparation of forecast flight schedules for use in simulation modeling and detailed terminal and landside analysis, as well as air quality analysis and detailed noise modeling.

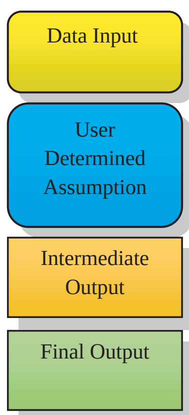
Chapter 7: Preparation of Day/Night and Stage Length Profiles for Noise Analysis provides techniques for calculating existing day/night and stage length profiles and estimating future day/night and stage length profiles for noise analysis by Integrated Noise Modeling (INM) or the forthcoming Aviation Environmental Design Tool (AEDT). Also included is a discussion of the factors that may cause the balance between day and night operations to change, along with some advice on avoiding common pitfalls.

Chapter 8: Preparation of Peak Period Forecasts discusses how to use the Toolbox to estimate peak period activity levels from design day profiles based on user-specified criteria. The chapter includes sample problems and provides some comments and cautions on how to calculate and use the results.

Chapter 9: Application of Constraints shows how physical or policy constraints may affect the magnitude of the peaks and the distribution of daily activity and provides guidance on how to model these aspects.

The Appendices include a user manual for the Toolbox (Appendix A), a list of useful data sources (Appendix B), default factors (Appendix C), suggested peak period definitions by facility type (Appendix D) and a Glossary of Terms (Appendix E). Additional background information is provided in the appendices of *ACRP WOD 14.*

Flow charts are provided in several of the chapters. The symbols used in this Guidebook are as follows:



A rounded yellow rectangle represents input from a data source or model.

A rounded blue rectangle represents an assumption provided by the Guidebook or Toolbox user.

An orange rectangle represents an intermediate process or model output.

A green rectangle represents a final process or model output.

1.4 Overview of Toolbox

The Toolbox that accompanies this Guidebook provides software to facilitate the calculation of many of the peak period and operational profiles discussed above. 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.

Appendix A provides a user manual for the Toolbox and several examples of how to use the Toolbox are provided in Chapters 4, 5, and 8. Note that the Toolbox is not designed to estimate more complex operational profiles such as day/night and stage length profiles or design day flight schedules.

CHAPTER 2

Background and Key Definitions

This chapter describes the relationship between annual forecasts, peak period estimates, and operational profiles. The chapter also provides some key definitions.

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. This chapter provides a brief overview of the annual forecasting process and the relationship between annual activity, the design day, the three types of operational profiles, and peak period estimates. Additional detail on operational profiles and peak period estimates is also provided.

Key components of airport activity forecasts include passenger enplanements, passenger originations, air cargo tonnage, and aircraft operations.

Each time a person boards an aircraft, he or she is counted as a **passenger enplanement**. Each time they disembark, they are counted as a **deplanement**. Passengers who begin the air portion of their trip at an airport are counted as an **originating passenger** at that airport. If they end the air portion of their trip at an airport, they 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 Annual Forecasts

There are four broad areas of airport activity: passenger, cargo, general aviation/for-hire air taxi, and military. The for-hire air taxi category is discussed in more detail in Section 2.1.3. The forecast drivers and the available data differ from category to category, and therefore the typical forecast approaches also differ.

2.1.1 Passenger Forecasts

Most passengers fly on scheduled carrier flights, flights that operate at times and on routes that are determined and published well in advance. There are three main ways of projecting scheduled passenger carrier activity; in order of increasing complexity, they are trend analysis, share analysis, and regression analysis.

Trend analysis consists of calculating the growth rate over a historical period of time and projecting that growth rate to continue into the future. This implicitly assumes that the factors that drove passenger growth in the past, such as income growth or changes in fares, will be the same in the future. Also, the resulting forecasts can be very sensitive to the period of time selected to calculate the historical growth rates.

Share analysis involves calculating passengers as a constant, increasing, or decreasing share of passengers in a regional or national forecast. This is an effective way of capturing anticipated changes in industry trends, assuming they have been captured in the national forecast, but it is not ideal for incorporating any local factors that diverge from national trends.

Regression analysis is a statistical method of generating an equation (or model) which best explains the historical relationship among selected variables, such as passenger enplanements and income. This approach allows the user to assess the impact of changes in forecast drivers, such as the local economy or airfares, upon future passenger enplanements. For this approach to work effectively, accurate projections of the forecast drivers are necessary.

These methods work best for local (origin and destination) passengers and airports where most of the passengers are local. Connecting passengers are driven more by the hub carrier's routing decisions than by the local economy. When information from the airline(s) is unavailable, the typical approach is to estimate connections as a constant, or an increasing or declining percentage of local passengers.

Passenger aircraft operations are usually estimated as a function of the passenger forecast instead of being projected independently. Typically, forecasts of passengers per operation are estimated based on assumptions for average seats per aircraft and load factor. In this instance, load factor represents the percentage of aircraft seats that are filled by passengers. These projections are then divided into the passenger projections to generate a forecast of passenger aircraft operations.

2.1.2 Air Cargo Forecasts

Air cargo includes both air freight and air mail. The approaches used to prepare annual cargo forecasts—trend, share, and regression analysis—are similar to those used to prepare passenger forecasts but are more difficult to apply for several reasons. First, although air cargo is time-sensitive, it is not as time-sensitive as passenger travel. Consequently, air cargo is more subject to competition from substitutes, either other modes of delivery, such as trucking, or other airports. Secondly, some types of data, like pricing, are much scarcer for air cargo than for passengers. Finally, the air cargo sector has evolved significantly over the past 30 years with the advent of door-to-door service by integrated carriers such as FedEx and UPS. This means that much of historical air cargo growth has been driven by service improvements, in addition to traditional drivers like economic growth and price.

Compared to passenger forecasts, the number of variables that need to be considered to forecast air cargo is greater, and the information available about those variables is less. Many forecasters therefore use share analysis, which relies on industry air cargo forecasts by the FAA or aircraft manufacturers that have the resources to analyze the myriad of issues.

Forecasts of air cargo aircraft operations are also more complex than the forecasts of passenger aircraft operations. First, cargo tonnage must be segmented between belly and all-cargo activity. Belly cargo, named because it is carried in the bellies of passenger aircraft, does not generate additional operations. All-cargo aircraft operations are usually estimated by projecting factors for average aircraft tonnage capacity and load factor. These factors are then used to estimate future tons per aircraft operation. Finally the forecast of total non-belly cargo is divided by the forecast of tons per operation to generate a forecast of all-cargo aircraft operations.

2.1.3 General Aviation and For-Hire Air Taxi Forecasts

General aviation operations include all operations other than commercial or military operations. For forecasting purposes, for-hire air taxi operations are often included with general aviation since the two categories share similar aircraft and data availability characteristics. The FAA defines an air taxi as "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."[i] Many of these air taxi operations are commercially scheduled passenger and cargo operations. The remaining air taxi operations include small aircraft hired for a specific purpose, as distinguished from regularly scheduled flights. Data for these for-hire operations are much scarcer than for scheduled commercial operations, so they are typically included with general aviation or forecast separately. At many smaller airports, the general aviation/for-hire air taxi category is the only relevant category.

The methods used to forecast general aviation and for-hire air taxi operations are similar to those used for commercial operations: trend, share, and regression analysis. Most general aviation activity is discretionary so the link with economic growth is weaker than is the case with commercial aviation and therefore, regression analysis is less effective. Because of this, many forecasters choose share analysis which relies on industry forecasts by the FAA or general aviation aircraft manufacturers who have the resources to analyze the business, social, and technological trends driving general aviation.

2.1.4 Military Operations Forecasts

Military aviation activity is determined by external events and policy factors, which are very difficult to forecast in the long term. Standard practice is to assume future military operations will remain at base year levels, unless information on a change in mission is available.

2.1.5 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. Some 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.

Master Plans

Airport master plans provide a roadmap for long-term airport development, typically over a period of 20 years. A master plan forecast generally provides more detail than the other sources and, if current, is usually the best choice for an annual forecast. Most master plan forecasts include a fleet mix forecast, which, when combined with base year day/night distributions and schedules, form a solid foundation from which to prepare future day/night splits and design day schedules.

System Plans

System plans involve the planning and prioritization of a regional system of airports, typically on a statewide basis. System plan forecasts are typically carried out to much less detail than master plans, and aside from critical aircraft information, do not provide much data on fleet mix. In addition, they tend to apply uniform forecast methodologies that may be optimal for the system but not necessarily for the specific airport in question.

FAA's Terminal Area Forecast

The FAA's TAF is revised yearly and is used to help determine FAA staffing levels, prioritize FAA capital spending, and to validate independent airport sponsored forecasts. Since the TAF is revised yearly for each airport, it is usually the most current alternative. It provides no fleet mix information, but does provide forecasts of both passengers and operations for air carriers and commuter/air taxis. This information, along with an estimate or assumption for load factor, can be used to estimate average seats per operation, which in turn can serve as a control on a future fleet mix estimate.

Detailed direction on the preparation of annual forecasts is beyond the scope of this Guidebook, but useful guidance on forecast approaches can be found in the following documents:

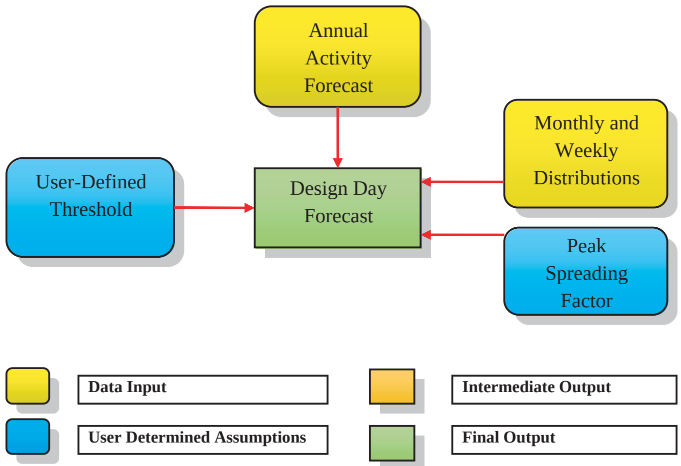
- FAA, *Airport Master Plans, Advisory Circular No: 150/5070-6B.*
- De Neufville, R. and A. Odoni, *Airport Systems: Planning, Design and Management*
- GRA, Inc. for FAA, *Forecasting Aviation Activity by Airport*
- Transportation Research Circular E-C040, *Aviation Demand Forecasting: A Survey of Methodologies,* TRB, National Research Council, Washington, DC, 2002
- William Spitz and Richard Golaszewski, *ACRP Synthesis 2: Airport Aviation Activity Forecasting,* TRB, National Research Council, Washington, DC, 2007
- ICAO, *Airport Planning Manual, Doc 9184-AN/902 Part 1, International Civil Aviation Organization*

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. 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.

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-

Exhibit 2.1. Relationship between annual activity forecasts and design day forecasts.



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.

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% × (100%–5%)].

The most common current practice in the United States is to define the design day as an 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. There are several other design day definitions in use, however, especially outside of the United States. Examples include the following:

- The average week day in the peak month (AWDPM)
- The 15th busiest day of the year
- The 30th busiest day of the year
- The 90th percentile—corresponds to the 36th busiest day of 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. This Guidebook provides the tools to customize the design day definition for the specific facility in question (see Chapter 4).

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 average annual day (AAD), which is annual activity divided by the number of days in the year.[ii] 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.[iii] The user should consult FAA and Environmental Protection Agency (EPA) guidance concerning acceptable design day definitions, especially when preparing National Environmental Policy Act (NEPA) documents.

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. Exhibit 2.2 shows examples of design day profiles for arriving and departing passengers at a connecting hub airport example.

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.

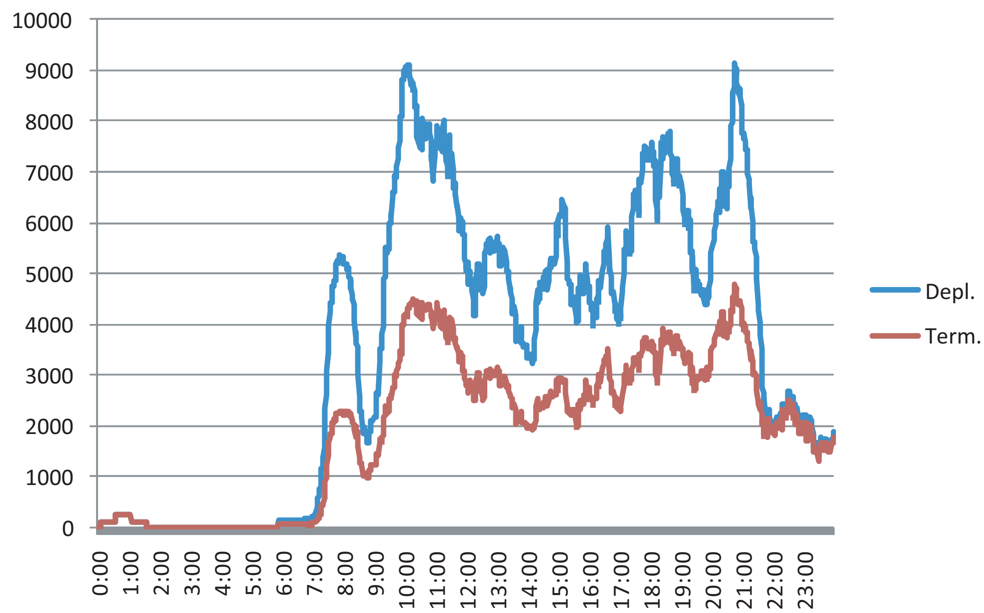
Exhibit 2.3 describes conceptually how design day profiles are derived from design day forecasts.

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.

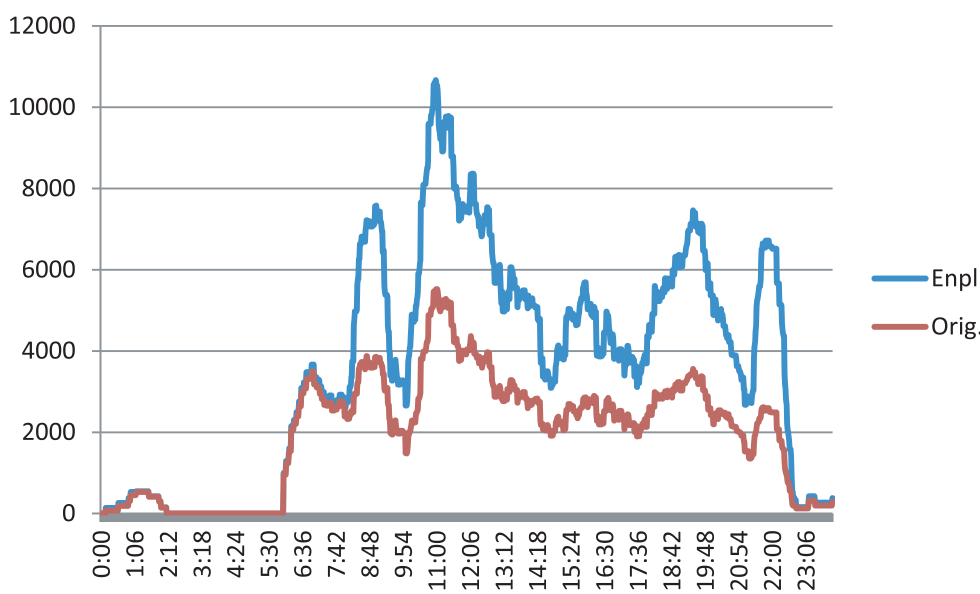
There are several ways of estimating future design day profiles. The simplest way is to assume that the base year distribution of daily activity will carry forward unchanged into the future. A second alternative is to assume a peak spreading component based on relationships between airport size and peak period percentage. This dampens the peaks and fills in the gaps in the daily

Exhibit 2.2. Design day passenger profiles—connecting hub airport example.

Arriving Passengers—Deplanements and Terminations

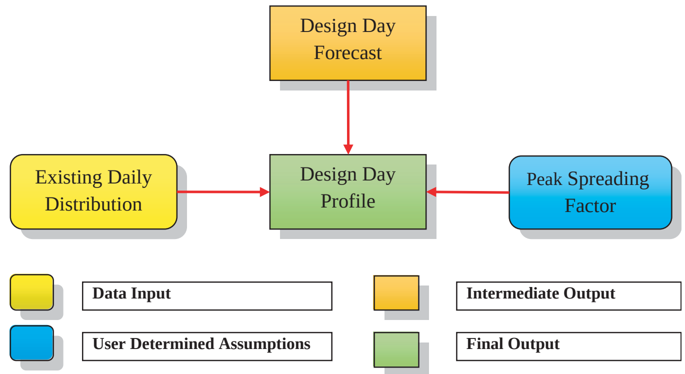


Departing Passengers—Enplanements and Originations



Source: HNTB extraction of hourly passenger flow data from gated flight schedule prepared for typical connecting hub airport.

Exhibit 2.3. Relationship between design day forecasts and design day profiles.



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 (O&D). 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.

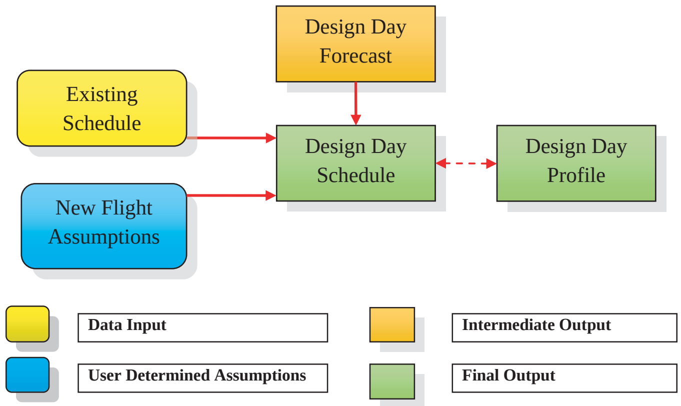
Design day schedules are also used for some types of environmental analysis. Air quality dispersion analysis requires most of the information needed for airfield planning to model aircraft emissions, and typically needs measures of local (non-connecting) passenger activity to help model ground vehicle movements. One type of noise modeling, the Noise Integrated Routing System (NIRS) model, requires most of the airfield components of a design day schedule but does not require the passenger information. More detailed information on the appropriate tools and forecasts for planning and environmental analysis is provided in Chapter 3.

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 2.4 shows conceptually how design day schedules are derived from design day forecasts.

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

Exhibit 2.4. Relationship between design day forecasts and design day schedules.



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 for additional detail.

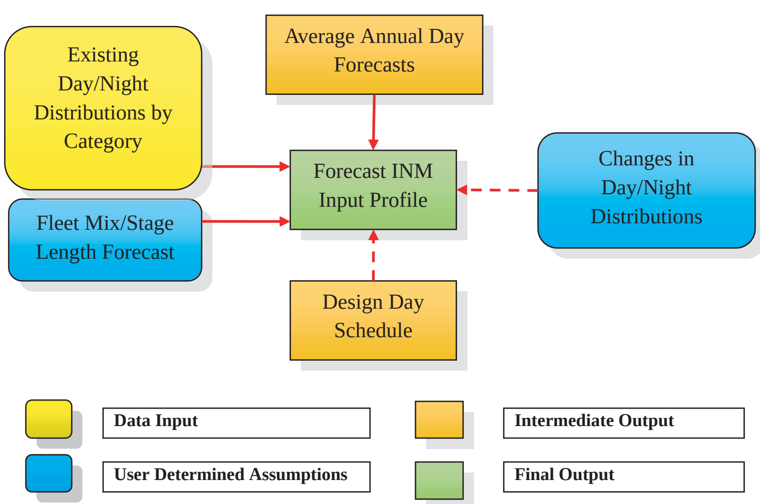
2.5 INM Input Profiles

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 2.5 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.

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

Exhibit 2.5. Relationship between average annual day forecasts and INM input forecasts.



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.

Often, the current practice is to maintain the current day/night split in each major category (e.g., passenger, cargo, and general aviation). If the relative contribution of each category to overall airport activity shifts over time, the overall day/night split will change. If not, it will remain constant.

The assumption of a constant day/night split within each category should be evaluated. 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 7 and Appendix I of the *ACRP WOD 14* for more detail.

The resources devoted to identifying future changes in day/night split should be based on an assessment of the potential changes to the noise impacts. For example, if there are a large number of older heavy cargo aircraft on the cusp of day and night, further investigation, including discussions with the air carrier may be warranted. If, alternatively, the potential shift is likely to involve piston-powered general aviation (GA) aircraft, the effect on the noise impacts would be much smaller, and less analysis would be warranted.

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.[iv]

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.[v] 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 2.6. Relationship between design day profiles and schedules and peak period forecasts.

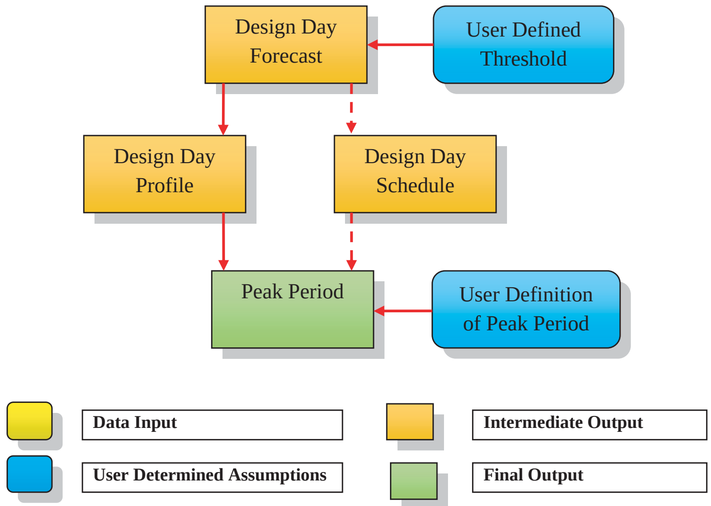


Exhibit 2.6 shows the relationship between the peak period and the design day (Section 2.2), and the design day profile (Section 2.3) or design day schedule (Section 2.4).

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.

The context in which the peak period occurs is important. If the time immediately preceding is also very busy, inherited queues and other activity may further exacerbate stresses occurring in the peak period. Likewise, if the succeeding period is busy, the ability of the facility to recover from the stresses of the peak will be impeded. Design day profiles (see Section 2.2) are useful for identifying these issues.

CHAPTER 3

How to Use Guidebook and Toolbox

This chapter provides guidance on identifying the appropriate forecasting tools for analyzing planning and environmental problems, depending on the specific issue and the level of detail required or possible. It also describes available default factors, the capability of generating multiple scenarios, and the identification of key variables. The limits of the Guidebook and Toolbox are also addressed.

The intent of this chapter is to help identify the appropriate type of forecast to use to consider peak period or operational profiles in addressing a planning or environmental issue. The chapter first reviews the identification of an issue, the types of tools that can be used to address these issues, and the types of forecasts required for these issues. Next, ways that the Guidebook and Toolbox can be used to enhance these forecasts are described, including default factors and multiple scenarios. The chapter closes with a discussion of the limits of the Guidebook and Toolbox.

3.1 Identification of Planning Issues and Appropriate Tools

The first step for determining the appropriate planning tool and corresponding forecast requirements is to identify the problem to be addressed. This section describes typical planning issues that are encountered, the appropriate tools for addressing those issues, and the types of forecasts required for those tools. Airfield planning, terminal planning, landside planning, and environmental planning are described separately.

Unlike airfield, terminal, landside, and environmental planning, airport financial planning has not required peak period estimates or design day profiles. To date, airport financial forecasts have been based on annual forecasts of passengers, cargo, and aircraft operations. On July 10, 2008, the U.S. Department of Transportation issued a rule allowing airports to increase landing fees during peak hours, and thus far the rule has been upheld in court. Should airports adopt peak hour pricing, landing fee revenues will be dependent on the time of day during which operations occur as well as the total number of operations. In the future, this may require design day profiles for financial forecasting in addition to the planning categories named in the previous paragraph.

The various analytical tools for airfield planning, terminal planning, landside planning and environmental planning are described as high detail, medium detail, and low detail:

- **High detail** methods require training for the specific models involved, are data-intensive, and require a substantial investment of time. For these reasons, they are best left to specialists.
- **Medium detail** methods require familiarity with airport planning or environmental analysis, and typically require several days of effort.
- **Low detail** methods can typically be done in a few hours if the necessary data and forecast information has been assembled.

3.1.1 Airside Planning

For the purpose of this Guidebook, 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). Exhibit 3.1 summarizes types of airfield facilities, the types of tools used to analyze and plan these facilities depending on the level of detail needed, and the types of forecasts required to use these tools.

The exhibit is organized according to three main categories: airfield, aircraft parking, and safety.

3.1.1.1 Airfield

Airfield planning involves an assessment of the ability of the existing or proposed airfield to accommodate aircraft movements under a variety of circumstances and often involves quantifying the efficiency of the airfield, using metrics such as delay. At most large airports, simulation models

Exhibit 3.1. Airside planning issues, tools, and forecast requirements.

Planning Problem/Issue		Level of Detail	Type of Analysis	Type of Forecast Required	Comments
Airfield	Capacity/Delay	High	Simulation Models (SIMMOD/TAAM)	Design Day Schedule	
		Medium	AC 150/5060 (forthcoming spreadsheet)	Daily Profile (operations and fleet mix)	
		Low	A/C 150/5060 (manual calculations)	Peak Period (fleet mix)	
	Operations and Efficiency	High	Simulation Models (SIMMOD/TAAM)	Design Day Schedule	Includes planning for taxiways, aprons, and hold pads.
		Medium/Low	Airfield Layout Analysis	Annual Fleet Mix	Includes planning for taxiways, aprons, and hold pads.
	Deicing	High	Simulation Models (SIMMOD/TAAM)	Design Day Schedule	
		Medium/Low	Spreadsheet Models	Peak Period (fleet mix)	
Aircraft Parking	Aircraft Parking	High	Gate Allocation Models	Design Day Schedule	
		Low	Departure per Gate	Annual Aircraft Departures	See ACRP Report 25 for more detail.
		Low	Enplanement per Gate	Annual Passenger Enplanements	See ACRP Report 25 for more detail.
		Low	Airline Input	n/a	
	Remote Overnight (RON) Parking	High	Gate Allocation Models	Design Day Schedule	
		Low	Departure per Gate	Annual Operations	
		Low	Enplanement per Gate	Annual Passengers	
		Low	Airline Input	n/a	
Safety	Airport Rescue & Firefighting (ARFF)	Medium	Airfield Layout Analysis	Annual Fleet Mix	
	Safety Areas and Zones	High	Airfield Layout Analysis	Annual Fleet Mix	Includes runway safety areas, protection zones, object free areas, obstacle free zones, and obstruction surfaces
	Safety (incursions)	High	Airfield Operations and Airfield Layout Analysis	Peak Period (fleet mix)	Does not include analysis of pilot demographics or ATC procedures

Definitions: SIMMOD = Computerized airport and airspace SIMulation MODel
TAAM = Total Airport and Airspace Modeler
High Detail = Resource intensive approach that requires specialized training.
Medium Detail = Requires several days of analysis and familiarity with airport facility or environmental planning.
Low Detail = Requires a few hours of analysis if necessary data are available.

Sources: ACRP Report 25: Airport Passenger Terminal Planning and Design (for aircraft parking), and HNTB analysis.
http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_025v2.pdf

such as SIMMOD and TAAM are used to evaluate airfield needs and proposed solutions. Following are some general considerations for determining the appropriate level of detail for airfield planning:

- New runways or runway extensions usually require FAA funding and a high level of environmental review, which then typically warrants the use of simulation modeling. A design day flight schedule is frequently used as input.
- If the analysis is at a stage where only initial screening of airfield development concepts is required, as in master plans, design day profiles of aircraft operations should be sufficient for preliminary analyses. The FAA is planning an update to its airport capacity and planning manual.[vi] 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. Second, 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. The model, as envisioned, will be a useful screening tool, and should function with operational profiles and not require the more complex design day schedules used by SIMMOD or TAAM.
- For conceptual long-term planning, which will not lead to design or construction without additional planning at a time closer to the implementation date, peak period estimates are often sufficient.
- At the majority of general aviation airports, activity tends to be low (i.e., less than 100,000 operations per year). In these instances, airfield capacity is not an issue. The need for new runways, if any, is driven by issues such as wind coverage or redundancy rather than capacity, and daily profiles or design day schedules are not necessary.

3.1.1.2 Aircraft Parking

Aircraft parking requirements are closely related to gate requirements. Aircraft parking needs, whether at-gate or remote, can be evaluated at a high level of detail using a design day schedule coupled with gating models, or at a low level of detail using ratio methods that directly relate the number of parking positions to annual enplanements or passenger aircraft operations.

A high level of detail is appropriate under the following circumstances:

- Significant increases in new types of activity that would affect apron utilization, such as international travel, are anticipated.
- Changes in lease agreements are anticipated, such as a change from exclusive use agreements under which a carrier has sole rights to a gate/parking position, to common use agreements, where carriers share gates and parking positions.
- Adding new parking positions would carry a high cost, so that prudence would dictate additional analysis to avoid overbuilding.

The methodologies used to estimate gate requirements in *ACRP Report 25: Airport Passenger Terminal Planning and Design* may be applied to estimating passenger aircraft parking requirements at a lower level of detail. In addition, airlines possess knowledge about their future scheduling plans and flexibility to modify schedules to increase aircraft parking utilization. This information is generally unavailable to airport planners, so input from airlines can also be useful in determining future gate requirements.

3.1.1.3 Airfield Safety

Planning for safety involves knowledge of airfield risk factors and FAA standards. It does not typically involve simulation modeling but risk may be assessed using information generated from these models. Detailed forecasts, other than fleet mix, are not necessary unless models are used.

3.1.2 Terminal Planning

For the purpose of this Guidebook, the terminal area is defined as the terminal building including all concourses and gates. Exhibit 3.2 summarizes the types of terminal facilities, the tools typically used to analyze and plan for these facilities depending on the level of detail desired, and the types of forecasts needed to employ these tools.

Exhibit 3.2. Terminal building planning issues, tools, and forecast requirements.

Planning Problem/Issue		Level of Detail	Type of Analysis	Type of Forecast Required	Comments
Gates	Gates	High	Gate Allocation Model	Design Day Schedule	
		Low	Departure per Gate	Annual Aircraft Departures	See *ACRP Report 25* for more detail.
		Low	Enplanement per Gate	Annual Passenger Enplanements	See *ACRP Report 25* for more detail.
		Low	Airline Input	n/a	
Passenger Departure Facilities	Ticket Counter	High	Simulation Models (ARCport)	Design Day Schedule	
		Medium	Mini-Queuing Models	Peak Period (originations)	See *ACRP Report 25* for more detail.
		Low	Ratio Methods	Peak Period (originations)	
	Ticket Queue	High	Simulation Models (ARCport)	Design Day Schedule	
		Medium	Mini-Queuing Models	Peak Period (originations)	See *ACRP Report 25* for more detail.
		Low	Ratio Methods	Peak Period (originations)	
	Passenger Security Screening	High	Simulation Models (ARCport)	Design Day Schedule	
		Medium	Mini-Queuing Models	Peak Period (originations)	See *ACRP Report 25* for more detail.
		Low	Ratio Methods	Peak Period (originations)	
	Baggage Security Screening	High	Detailed Planning Analysis	Design Day Profile (originations)	
		Low	Spreadsheet Models	Peak Period (originations)	See *ACRP Report 25* for more detail.
	Baggage Make Up Area	Medium	Baggage Make-up Model	Equivalent Aircraft (EQA)	See *ACRP Report 25* for more detail.
		Low	Ratio Methods	Equivalent Aircraft (EQA)	See *ACRP Report 25* for more detail.
		Low	Spreadsheet Models	Peak Period (originations)	
	Departure Lounges (Holdrooms)	Low	Ratio Methods	Gate Requirements Forecast	See *ACRP Report 25* for more detail.
Passenger Arrival Facilities	Customs & Border Protection	High	Simulation Models	Design Day Schedule	
		Medium	Queuing Models	Peak Period (international deplanements)	See *ACRP Report 25* for more detail.
		Low	Ratio Methods	Peak Period (international deplanements)	
	Meeting/Greeting Area	High	Simulation	Design Day Schedule	
		Medium	Ratio Methods	Design Day Profile (O&D passengers)	
		Low	Ratio Methods	Peak Period (O&D passengers)	
	Baggage Claim Frontage	High	Simulation Models	Design Day Schedule	
		Low	Ratio Methods	Peak Period (passenger terminations)	See *ACRP Report 25* for more detail.
	Baggage Claim Units	High	Claim Unit Models	Design Day Schedule	See *ACRP Report 25* for more detail.
		Low	Ratio Methods	Peak Period (aircraft arrivals)	

(continued on next page)

Exhibit 3.2. (Continued).

Planning Problem/Issue		Level of Detail	Type of Analysis	Type of Forecast Required	Comments
Other Facilities	Concourse Circulation	Medium	Terminal layout analysis	Gate Requirements Forecast	Function of gates and concourse layout
	Terminal Circulation	Medium	Terminal layout analysis	n/a	Function of terminal layout
	Restrooms - Terminal	Low	Ratio Method	Peak Period (O&D passengers)	See *ACRP Report 25* for more detail.
	Restrooms - Concourse	Low	Ratio Method	Peak Period (deplanements)	See *ACRP Report 25* for more detail.
	Concessions	Medium	Spreadsheet Models	Annual Passengers	
	Rental Car Counter & Offices	Medium	Ratio Method	Peak Period (O&D passengers)	
		Low	n/a	n/a	Provided by tenants
	Airline Offices and Operations & Maintenance	Low	n/a	n/a	Provided by airlines

Definitions: SIMMOD = Computerized airport and airspace SIMulation MODel
TAAM = Total Airport and Airspace Modeler
High Detail = Resource intensive approach that requires specialized training.
Medium Detail = Requires several days of analysis and familiarity with airport facility or environmental planning.
Low Detail = Requires a few hours of analysis if necessary data are available.

Sources: *ACRP Report 25: Airport Passenger Terminal Planning and Design*, and HNTB analysis.

There are four main categories, including gate analysis, departing passenger facilities, arriving passenger facilities, and other terminal facilities, in the exhibit. Many of the tools presented in the exhibit can be directly accessed in *ACRP Report 25.*

3.1.2.1 Gates

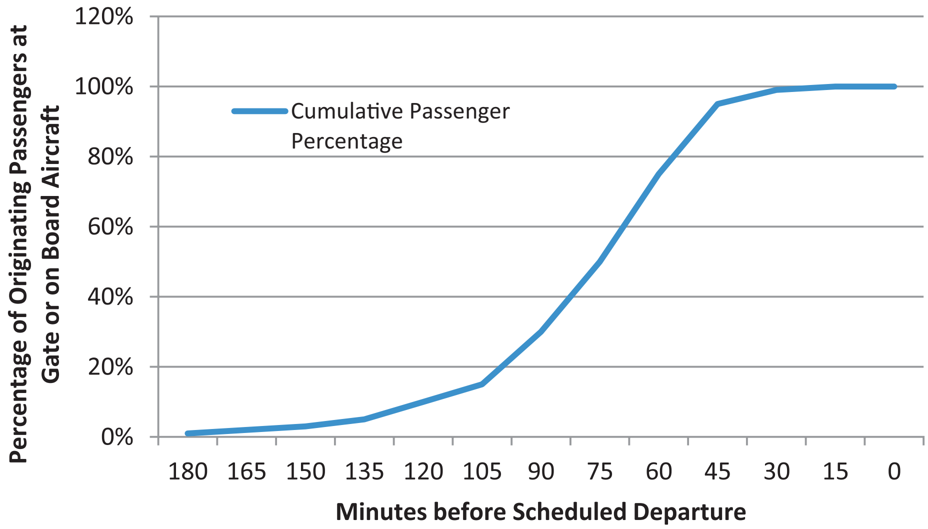
The planning techniques used to identify gate requirements are very similar to those used to determine passenger aircraft apron requirements (see Section 3.1.1.2). Specifically, if new activity that would affect the intensity of gate use, if changes in lease terms that would affect how carriers share gates, or if expansion would carry a high cost, a high detail analysis involving a design day schedule should be considered.

3.1.2.2 Departing Passenger Facilities

Ticketing facilities, security screening, baggage make-up areas, and holdrooms all serve departing passengers (enplanements). Except for holdrooms, the demand for these facilities is determined by originating enplanements. Holdrooms accommodate both originating and connecting enplanements.

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 the size and configuration of the airport, 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 (please see generic example in Exhibit 3.3). Additional discussion on the importance of lead and lag times can be found in *ACRP WOD 14* (Appendix P). As a result of the combination of the

Exhibit 3.3. Cumulative passenger percentage.



Source: HNTB analysis.

Note: Lead and lag time distributions vary significantly by airport and according to security protocols currently in place; therefore any distributions that are used should be based on information from the airport under study.

lead time and probability distribution, the timing and intensity of the peak period flow at a given departure facility may not exactly match the enplaning peak.

In addition, the following factors should be considered when determining the level of forecast detail for terminal planning:

- At large airports, with a wide variety of airline services and passenger characteristics, inferring the appropriate passenger distributions for each departing passenger facility becomes increasingly complex, and a terminal simulation model requiring a design day schedule may be appropriate. Also, since a design day schedule disaggregates activity down the flight level, it can be used to prepare design day profiles at the concourse or terminal level, in addition to the airport level.
- For detailed analysis that will lead to the design and construction of terminal facilities, and which involves the evaluation of multiple configuration alternatives, daily passenger profiles segmented by category (domestic/international, originating/connecting, or other relevant characteristics) and airline are preferred.
- For conceptual long-term planning, which will not lead to design or construction without additional planning at a time closer to the implementation date, peak period estimates are sufficient.

3.1.2.3 Arriving Passenger Facilities

Arriving passenger facilities include Customs and Border Protection, meeting/greeting areas, and baggage claim facilities. The planning issues for arriving passenger facilities are similar to those for departing passenger facilities, except that the peak flows are determined by deplaning passengers, especially those that are terminating their trip at the airport. In addition, the timing of the impact on arriving passenger facilities lags the deplaning peak.

3.1.2.4 Other Terminal Facilities

Some terminal facilities, including concourse and terminal circulation space, restrooms, concessions, and rental car counters, serve both arriving and departing passengers. Others such as airline offices are not directly affected by peak passenger activity. With the exception of the demand for restrooms, which is determined by a combination of peak arriving and departing passengers, the demand for most of these activities is determined by annual passenger levels or the configuration of other facilities such as gates.

3.1.3 Landside Planning

For the purpose of this Guidebook, 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. Exhibit 3.4 summarizes the types of landside facilities, the tools typically used to analyze and plan for these facilities depending on the level of detail needed, and the types of forecasts needed to use these tools. Landside facilities fall into two major categories: (1) roadway access, including curbs, and (2) parking.

3.1.3.1 Roads and Curbs

Access roads provide entry to the curbs and automobile parking at the airport; the majority of these facilities are impacted by activity of both originating and terminating passengers. In general the requirements for the departure curb and access roads to parking facilities are determined by originating passengers and their vehicles, while requirements for the arrivals curb and roads which egress from parking facilities are determined by terminating passengers and their vehicles. More specific to the curb roadways, many airports serve both arriving and departing passengers with the same curb; in this case demand is determined by a combination of arriving and departing passengers.

Exhibit 3.4. Landside planning issues, tools, and forecast requirements.

Planning Problem/Issue		Level of Detail	Type of Analysis	Type of Forecast Required	Comments
Roads and Curbs	Access roads	High	Simulation Models (e.g., VISSIM)	Design Day Profile (O&D)	
		Low	Roadway Layout Analysis	Peak Period (O&D)	
	Curb Capacity - Private Auto	High	Simulation Models	Design Day Profile (O&D)	
		Low	Spreadsheet Analysis	Peak Period (O&D)	
	Curb Capacity - Commercial	High	Simulation Models	Design Day Profile (O&D)	
		Low	Spreadsheet Analysis	Peak Period (O&D)	
Parking	Parking - Hourly	Low	Ratio Methods	Peak Period (O&D)	Ratios tend to be airport-specific.
	Parking - Daily	Low	Ratio Methods	Design Day (O&D)	Ratios tend to be airport-specific.
	Parking - Long Term	Low	Ratio Methods	Design Day (O&D)	Ratios tend to be airport-specific.
	Rental Car	Low	Ratio Methods	Design Day (O&D)	Ratios tend to be airport-specific.
	Entry/Exit Plazas	High	Simulation Models	Design Day Profile (O&D)	
		Low	Ratio Methods	Peak Period (O&D)	
	Parking – Taxi Hold	Medium	Queuing Models	Design Day Profile (O&D)	
		Low	Ratio Methods	Peak Period (O&D)	
	Parking – Cell Phone Lot	Medium	Policy	Peak Period (terminations)	Diverts activity from both hourly parking and curbside so has both congestion and revenue implications.
	Parking – Employee	Medium	Spreadsheet Analysis	Design Day Profiles (employees)	Function of number of employees and timing of shifts.
		Low	Ratio Models	Annual Employees	

Definitions: VISSIM - (Verkehr in Stadten - Simulation) micro-level traffic simulation model.
O&D- origin and destination passengers
High Detail = Resource intensive approach that requires specialized training.
Medium Detail = Requires several days of analysis and familiarity with airport facility or environmental planning.
Low Detail = Requires a few hours of analysis if necessary data are available.

Source: HNTB analysis.

Curb and roadway requirements are highly sensitive to the configuration of the airport: the segregation of different types of demand (e.g., passenger versus employee), and the segregation by vehicle type (e.g., private auto versus courtesy van). Therefore, simulation models using design day profiles are often used to model these more complex interactions.

The guidelines for landside planning are similar to those for terminal planning, although lead times for departing passengers and lag times for arriving passengers are greater. The connection between enplaning/deplaning peaks and curbside and roadway peaks tends to be more tenuous than those seen in the terminal. In addition, the demand on roads and curbs will depend on the airport specific passenger transportation mode. Transportation mode is very sensitive to whether the passenger is a resident or non-resident, which in turn is sensitive to time of day. See the *ACRP WOD 14* (Appendix K) for more discussion.

When choosing an analytical method and forecast for access road or curb analysis, the following should be considered:

- At a multiple terminal airport, where loads on curbs may depend on which airlines are assigned to which terminals, airline specific design day passenger profiles or a design day flight schedule will be required.
- For conceptual long-term planning, peak period estimates derived from design day profiles should be sufficient. Alternatively, an empirical analysis based on identifying the current distribution of vehicle traffic by time of day and scaling up based on the growth in passenger originations may be more cost-effective.

3.1.3.2 Parking

From an analytical standpoint, parking can be broken out into two main categories, very short term and other. The very short term category includes hourly parking, cell phone lots, and taxi hold areas. Planning for these categories typically relies on peak period vehicle forecasts, which are determined principally by passengers. To account for lead and lag factors, these should be derived from daily passenger profiles. Other longer-term parking demand is dependent on the accumulation of demand rather than peak demand flows. Hence, design day forecasts of O&D traffic are sufficient to forecast requirements for these types of parking.

The sizing of entry and exit parking plazas is dependent on peak traffic flows. More detailed analyses use simulation, similar to many roadway analyses.

3.1.4 Environmental Planning

As it relates to airports, most quantitative airport activity-related environmental planning is devoted to noise and air quality analysis. The tools used for these analyses may differ depending on whether the focus is the airfield or the landside. Exhibit 3.5 summarizes the types of environmental impacts, the tools typically used to analyze these types of environmental impacts depending on the level of detail needed, and the types of forecasts needed to employ these tools. There are many additional environmental impact categories, such as historic and archeological resources, fish and wildlife, endangered species, socioeconomic impacts, and hazardous materials but their analysis is not dependent on measures of passenger or aircraft activity and therefore is not addressed in this section.

3.1.4.1 Noise Analysis

In most instances, noise analysis is governed by 40 CFR Part 150 and FAA NEPA guidance in FAA Order 1050.1E: Policies and Procedures for Considering Environmental Impacts, and FAA Order 5050.4B: National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions. Therefore, there is less flexibility in choosing analytical tools than with planning.

Exhibit 3.5. Environmental planning issues, tools, and forecast requirements.

Planning Problem/Issue		Level of Detail	Type of Analysis	Type of Forecast Required	Comments
Noise	Noise - Airport	High	NIRS/AEDT	Design Day Schedule	
		Medium	INM/AEDT	Day/Night & Stage Length Profile	
		Low	AEM	Day/Night Profile	Screening tool used to estimate impact of changes in aircraft operations.
	Noise - Landside	Medium	TNM	Design Day Profile (originations)	
	Noise - Airspace	High	NIRS/AEDT	Design Day Schedule	
		Medium	NST	Profile of Proposed change in aircraft operations.	Used to estimate impact of changes in aircraft operations.
Air Quality	Inventory	Medium	EDMS/AEDT	AAD Fleet Mix	
	Dispersion - Airside	High	EDMS/AEDT	Design Day Schedule	
	Dispersion - Landside	High	EDMS/AEDT	Design Day Schedule	

Definitions:
NIRS- Noise Integrated Routing System model
AEDT- Aviation Environmental Design Tool (forthcoming)
INM- Integrated Noise Model
AEM- Area Equivalent Method (spreadsheet model)
TNM- Traffic Noise Model
NST- NIRS Screening Tool
EDMS- Emissions and Dispersion Modeling System
MOVES2010- Motor Vehicle Emission Simulator (2010 version)
High Detail = Resource intensive approach that requires specialized training.
Medium Detail = Requires several days of analysis and familiarity with airport facility or environmental planning.
Low Detail = Requires a few hours of analysis if necessary data are available.

Source: HNTB analysis.

Noise impacts from aircraft are usually estimated using the INM which has specific input requirements, namely AAD aircraft operations broken out by day/night split and aircraft type. The NIRS model is sometimes used instead; however, it requires a design day schedule as an input. The Area Equivalent Model (AEM) is a simpler spreadsheet analysis, but is limited to use as a screening tool to determine whether a change in aircraft mix will create a significant change in noise contours.

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.

Noise impacts resulting from regional airspace use are currently evaluated using NIRS, which requires a design day schedule as an input. The impact of small incremental changes to airspace use can be evaluated using the NIRS Screening Tool (NST).

The AEDT will eventually be able to calculate aircraft and airspace noise impacts along with airfield and landside air quality impacts. In effect, it will replace the INM, NIRS, and Emissions and Dispersion Modeling System (EDMS) models but will use the same inputs depending on the specific analysis required.

3.1.4.2 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.

The EDMS is currently used to perform air quality inventories and air quality dispersion analysis resulting from airport activity. The inventory analysis requires a fleet mix for the average annual day. The dispersion analysis information needs are more detailed and require the output from an airfield simulation model such as SIMMOD or TAAM. Consequently a design day schedule is needed as a forecast input.

The upcoming AEDT model will replace the EDMS model and the INM model; however, the input requirements will generally be the same.

3.2 Default Factors

The seasonal, weekly, and hourly distribution of activity for airports varies depending on their size, their location, and the types of communities they serve. At most airports, this type of information is readily available for aircraft operations, but less so for weekly and hourly passenger distributions. Typically this information is available only from the airlines or by undertaking extensive monitoring programs. It is difficult to obtain cooperation from all airlines, and monitoring programs are time-consuming and expensive. To provide an alternative, the Toolbox provides optional default factors for day-of-week load factors, time-of-day seat factors (enplaning/deplaning load factors), and peak hour spreading factors.

3.2.1 Day-of-Week Default Factors

As part of the research supporting this Guidebook, information was collected from participating airlines to identify day-of-the-week seat factors by airport size and time zone (see Appendix C). A review of the data indicates that there is strong statistical support finding that some days of the week have higher seat factors than others, and that in most cases, the busier days are Fridays and Sundays, and the less busy days are Tuesdays and Wednesdays (see *ACRP WOD 14,* Appendix F). Nevertheless, there is significant variation from airport to airport, so day-of-the week data specific to the airport should be collected if possible.

3.2.2 Time-of-Day Default Factors

In addition to day-of-the-week passenger information, participating airlines were requested to provide time-of-day seat factors (enplaning and deplaning load factors) by airport size and time zone (see Appendix C). A review of the data suggests that seat factors for arrivals tend to be higher in the afternoon and early evening than the remainder of the day, and that seat factors for departures tend to be higher in the late morning and early afternoon than elsewhere in the day. There is significant variation from airport to airport, so the hourly variations from the mean are not statistically significant at a strong confidence level. Therefore, hourly data specific to the airport should be collected if possible. If airport-specific data is not available, it is recommended that the hourly default factors be used only for sensitivity analyses.

3.2.3 Peak Spreading Default Factors

The Toolbox calculates alternative values for design day profiles and peak period estimates based on a default peak spreading factor that reduces the peak periods (as a percentage of daily operations) and increases the off-peak periods to compensate, as design day operations increase. The default peak spreading factor is based on an analysis of the relationship between peak hour percentage and total annual operations (see *ACRP WOD 14,* Appendix H, for additional background).

Based on the analysis in Appendix H, 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 aircraft arrivals/departures. In addition, the variability in the peak hour percentage is much greater for small airports than for large airports. Also, there is a minimum 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, peak spreading is likely to be much less than if it lies at the high end of the range.

Other factors that can influence the extent of peak spreading include:

- Average Aircraft Size: If airlines reduce the average size of the aircraft serving an airport, flight frequency increases but the size of the aircraft serving the peak decreases. This tends to increase peak spreading. Alternatively, peak spreading is less likely if the average aircraft size increases.
- Number of Airlines: When airport growth is achieved by adding additional airlines, they often compete during the peak, thereby reducing the extent of peak spreading. Conversely, when growth is achieved by existing airlines adding new flights, the flights tend to be added during off-peak hours, thereby increasing the degree of peak spreading.
- Type of Passenger Service: Overseas international flights normally operate within restricted windows. Therefore, new international service to an existing region is less likely to result in peak spreading than new domestic service.
- Type of Cargo Service: Integrated air cargo carriers such as FedEx and UPS have narrow sort windows and therefore are much less able to spread their operations than are non-integrated air cargo carriers.

3.3 Forecast Uncertainty and the Use of Scenarios

This section provides an overview of the types of forecast uncertainty, and how to use scenario analysis with the assistance of the Toolbox to address this uncertainty. Additional guidance on treating forecast uncertainty will be forthcoming from ACRP Project 3-22, "Incorporating Uncertainty and Risk into Airport Air Traffic Forecasting."

3.3.1 Forecast Uncertainty

Three types of uncertainty are addressed: (1) variance in the annual forecasts, (2) variance between the annual forecasts and the measures of peak activity, and (3) variance between scheduled and actual activity.

Forecasts are inherently uncertain. Annual activity projections are subject to forecast variance because of unforeseen changes in economic conditions, changes in airline cost factors (e.g., fuel), changes in airline business models, and changes in regulations and security measures. These uncertainties carry over into the design day, operational profile, and peak period estimates that are based upon the annual projections.

Changes in the relationship between annual activity and the design day, operational profile, and peak period estimates are also subject to uncertainty, and introduce an additional element of variance. For example, a carrier may choose to increase the number of connecting banks at an airport without increasing the total number of flights. The result would be a decrease in peak period activity that would not be projected with traditional forecasting techniques.

Airlines are not always able to operate consistently with their schedules. Therefore, even if a practitioner precisely projects 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. Since international flights tend to be longer, deviations from schedule resulting from stronger than expected headwinds or tailwinds become important considerations. A slight shift in one or two flights can result in a concentrated peak that may overwhelm facilities that are designed for the projected schedule. Manual adjustments to the schedule input data could be used to model such instances within the Toolbox (see Chapter 8).

3.3.2 Use of Scenarios

One method of addressing uncertainty is to use forecast scenarios. Forecast scenarios, in the form of high and low range forecasts, or more detailed contingencies based on variation of specific variables such as economic growth, are often used to portray the potential variance in annual forecasts. The Toolbox provides a means of quickly generating similar alternative forecast scenarios of design day, operational profile, and peak period activity levels. The Toolbox can:

- Show the effect of an annual forecast scenario upon the design day, operational profile, or peak period measures.
- Provide the ability to specify alternative relationships between annual and peak activity levels, such as day-of-the-week and hour-of-the-day enplaning load factors and peak spreading factors.

More specific examples are provided in Chapters 4, 5, and 8.

3.4 Identification of Key Variables

The Toolbox can be used to test multiple relationships between annual and peak activity levels. The results of these tests can help identify the specific variables that have the greatest impact on peak period estimates and the facilities they affect. This information can then help determine where to devote resources to collect more information.

For example, the Toolbox can be used to run sensitivity tests with and without the default day-of-the-week enplaning load factor adjustment factors. If the difference in resulting peak period passenger levels is very little, it is not necessary to take the time and effort to collect day-of-the-week data from the airlines. Alternatively, if the tests show a significant difference in peak period estimates with and without the default day-of-the-week factors, it would indicate that collecting airport-specific day-of-the-week data from the airlines would enhance accuracy.

Another example would be a test of the time interval from when a passenger arrives at curbside to when the passenger boards an aircraft. These lead times are affected by security policies imposed by the Transportation Security Administration (TSA) and can be very difficult to forecast. The Toolbox can be used to test several alternative lead times to identify their potential impact on the derivative curbside daily profile. At airports where arriving and departing passengers use the same curb, the lead time could change sufficiently to cause arriving and departing curbside peaks to become superimposed, significantly increasing curbside congestion. A sensitivity analysis using the Toolbox can help alert the planner to such potential problems.

3.5 Limits of Guidebook and Toolbox

Airports are complex entities, and even intricate simulation models provide only a simplified representation. Likewise, this Guidebook and Toolbox cannot describe all the nuances associated with an airport operation. In the case of the high detail analyses described in Exhibits 3.1, 3.2, 3.4, and 3.5 particularly, professional assistance is recommended.

CHAPTER 4

Preparation of Design Day Forecasts

This chapter shows how to use the Toolbox to define and estimate the design day from current or forecast annual data. The chapter includes sample problems and provides some comments and cautions on the use of the data.

This chapter provides approaches to estimating design day operations and passengers based on a user-defined design day.

4.1 Aircraft Operations

4.1.1 Existing Design Day Operations

A simple approach to estimating existing design day aircraft operations is provided in Exhibit 4.1. The first step is to decide on the design day definition. See Section 2.2 for a discussion of the purpose of the design day. For example, if the design day is intended to represent activity that equals or exceeds activity in all but five percent of the year, the 18th busiest day of the year (5% multiplied by 365 days) should be selected. Note that the design day does not need to be limited to a single definition; the same data can be used to calculate multiple definitions of the design day. Likewise, this approach can be used to calculate design day levels for different categories of aircraft operations—provided information on these operations by category is available on a daily basis.

In the United States, the ADPM is most commonly used to represent the design day for facility planning. Depending on the seasonal and weekly distribution of activity at the airport, the ADPM can translate to a broad range of busy day percentages. For example, the ADPM can represent a design day representing the 5th percent busiest day at a highly seasonal airport, or the 40th percent busiest day at an airport with very low seasonality.

Calculation of design day operations requires data on the number of aircraft operations by day for a calendar year or contiguous 12-month period. This information is available at towered airports and can be obtained from the FAA website at http://aspm.faa.gov/. See Appendix B for more detail on data sources.

4.1.2 Future Design Day Operations

Future design day operations can be calculated once existing design day operations have been estimated. Exhibit 4.2 provides an approach to projecting future design day operations.

4.1.3 Use of Toolbox

The operations module of the Toolbox provides a quick method of estimating design day operations. The following sample problem shows how to use the Toolbox to calculate design day operations.

Exhibit 4.1. Process for estimating existing design day aircraft operations.

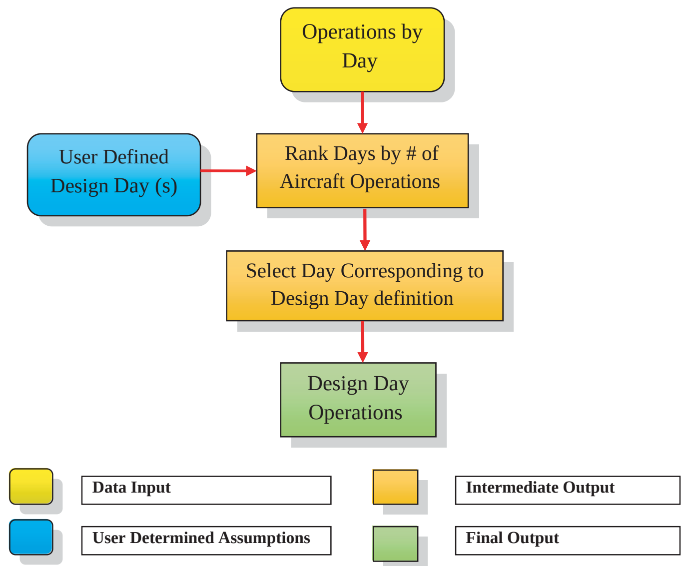
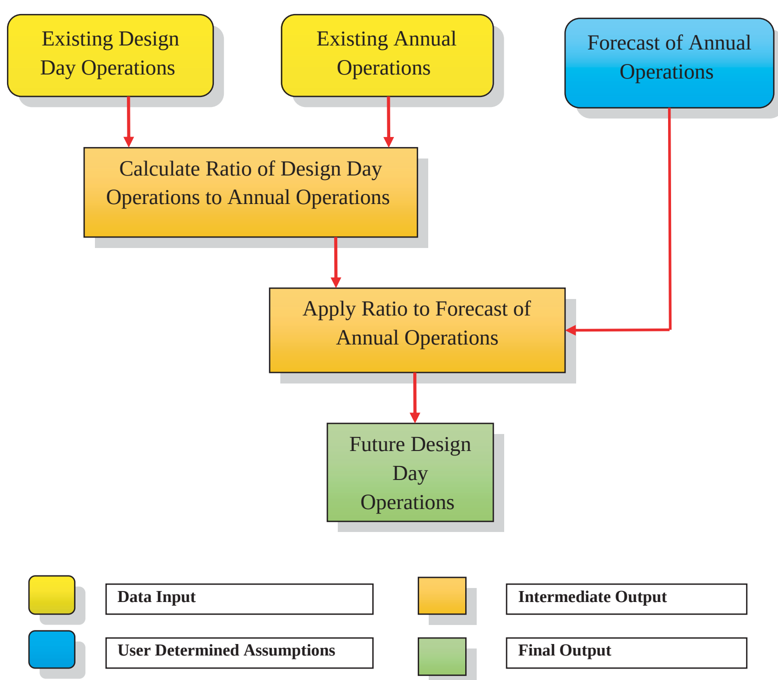


Exhibit 4.2. Process for estimating future design day aircraft operations.



Sample Problem 4.1

Problem Statement: Estimate Fuel Farm Requirements

Airport: General Aviation Airport in Central Time Zone

Planning Factor: Gallons per Design Day Operation

Forecast Element: Design Day Operations

Toolbox Module: Operations

In this case, an airport planner needs to estimate fuel farm requirements in 2020. The planner wants to ensure the capacity is adequate to meet demand 95 percent of the time. Based on analysis in a recent master plan for the airport, the fuel farm must be sized to provide 150 gallons of capacity (including reserves) for each design day operation. The planner enters the scenario name (A), 2025 annual aircraft operations (B), operations type (C), and design day definition (D) in the *B. User Selected Parameters* worksheet of the Operations Module as in Exhibit 4.3.

Exhibit 4.3. Process for estimating existing design day operations.

	A–G	H	I–J
1	AIRPORT COOPERATIVE RESEARCH PROGRAM		
2	Peak Period and Operational Profile Toolbox		
3	Aircraft Operations Module		
4			
5	USER SELECTED PARAMETERS		
6			
7	Scenario Name: Sample Problem 4.1		A
8			
9	Enter Forecast of Aircraft Operations (Annual Total)	106,127	B
10			
11			
12	Select Operations Type to be Analyzed	Both	C
13			
14	Do you want to define the Design Day as Average	No	
15	Day Peak Month (Yes/No)		
16			
17	Enter Design Day Definition (s) (Up to 7)	5%	D
18	(For example, if you want your design	1%	
19	day to represent the top 10 percent	2%	
20	busiest day of the year (roughly 36th	10%	
21	busiest day) enter 10).	15%	
22		20%	
23		25%	
24		33%	ADPM
25			

B.User Parameters

Exhibit 4.4. Process for estimating future design day operations.

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

BASE YEAR DATA

Base Year - Schedule Data for Representative Day

Time	Arrival/Dept.	Category	Equipment

Base Year - Operations by Day of the Year

MM/DD/YYYY	Arrival	Departure	Total
1/1/2009	44	45	89
1/2/2009	148	152	300
1/3/2009	21	23	44
1/4/2009	37	38	75
1/5/2009	202	206	408
1/6/2009	203	203	406
1/7/2009	53	54	107
1/8/2009	175	177	352
1/9/2009	104	106	210
1/10/2009	137	139	276
1/11/2009	61	61	122
1/12/2009	42	43	85
1/13/2009	110	112	222
1/14/2009	92	93	185
1/15/2009	104	104	208
1/16/2009	90	92	182
1/17/2009	12	15	27
1/18/2009	20	21	41
1/19/2009	136	143	279
1/20/2009	197	197	394
1/21/2009	120	122	242
1/22/2009	208	209	417

Although planning for the five percent busiest day, the planner includes other design definitions to provide additional background and context. Since peak period information is not required for this problem, peak period input parameters are ignored.

In the *C. Base Year Data* worksheet of the Module (Exhibit 4.4) the planner inputs annual operations by day for 2009, which in this instance was obtained from the FAA Enhanced Traffic Management System Counts (ETMSC) website. Base year schedule data is not required since peak period forecasts are not needed for this problem.

The design day forecast is provided in the *D. Design Day* worksheet (Exhibit 4.5). As shown, projected design day operations are 538 with a 5 percent design day definition. With a planning factor of 150 gallons per design day operation, this translates to a fuel farm capacity requirement of 80,700 gallons (538 design day operations multiplied by 150 gallons per design day operation = 80,700 gallons).

The planner notes that design day operations at the one and two percent levels are much higher than at the five percent level and makes a note to inform the Airport Authority that there would be a risk of a significant fuel capacity shortfall on extremely busy days. The planner also notes that if the traditional ADPM criterion had been used, the design day operations would

Exhibit 4.5. D. design day worksheet.

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

DESIGN DAY OPERATIONS ESTIMATES
Sample Problem 4.1

Base Year

Design Day & Average Annual Day (AAD)

Combined Arrivals and Departures

Selected top X % busiest day	Rank	Total Ops Count	Corresponding Calendar Date
ADPM	120	297	8/22/2009
5%	18	463	8/17/2009
1%	3	558	5/7/2009
2%	7	522	5/5/2009
10%	36	417	1/22/2009
15%	54	378	3/7/2009
20%	71	344	2/19/2009
25%	91	323	1/26/2009

Combined Arrivals and Departures

Annual Total =	91,304
Average Annual Day (ADD) Total =	250

Forecast Year

Future Design Day & Average Annual Day (AAD)

Combined Arrivals and Departures

Selected top X % busiest day	Rank	Future Design Day operations
ADPM	120	345
5%	18	538
1%	3	649
2%	7	607
10%	36	485
15%	54	439
20%	71	400
25%	91	375

Combined Arrivals and Departures

Future Annual Total =	106,127
Future Average Annual Day (ADD) Total =	291

ADPM: Average Day in Peak Month

Base Year Annual Operations	91,304
Forecast Year Annual Operations	106,127
Design Day Definition	5%

D.Design Day

have been 345 operations, which would have resulted in a fuel farm capacity of 51,750 gallons (345 design day operations multiplied by 150 gallons per design day operation = 51,750 gallons), and that demand would have exceeded capacity 120 days of the year.

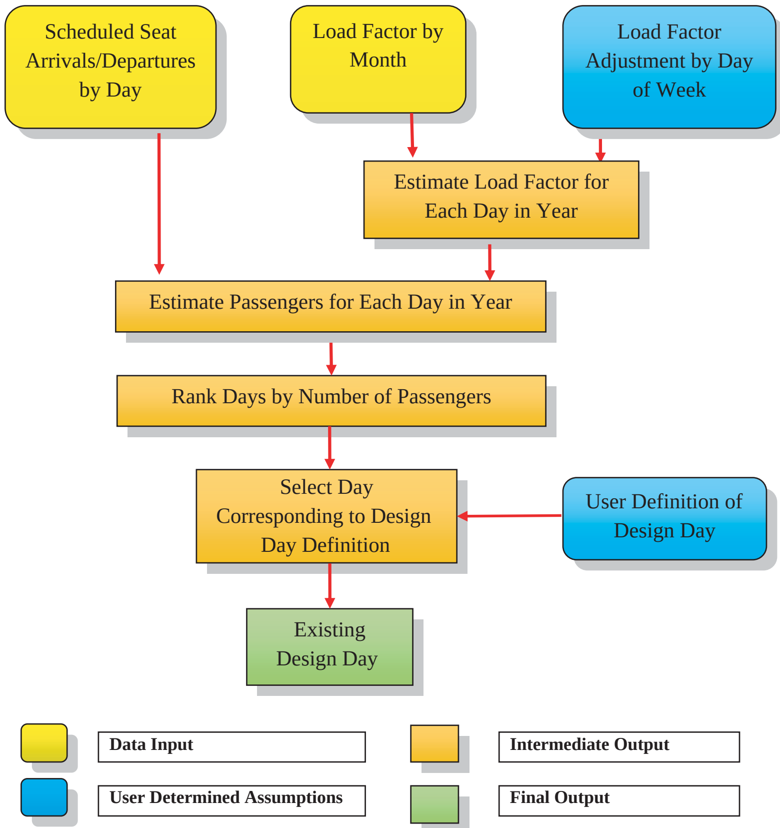
4.2 Passengers

4.2.1 Existing Design Day Passengers

The general approach to estimating existing design day passengers is similar to the approach for estimating design day operations. Since daily data on passenger levels is typically unavailable, additional steps are required for the estimate. Exhibit 4.6 shows the typical approach for estimating design day passengers.

Scheduled seat arrival and departure data on a daily basis can be obtained from sources such as the Official Airline Guide (OAG) (see Appendix B for more detail). Passengers can be estimated from the seat data by applying load factors. These load factors can vary by month and

Exhibit 4.6. Process for estimating existing design day passengers.



by day-of-the-week. Monthly load factors can be obtained from the U.S.DOT's T-100 database (see Appendix B for more detail) or can be calculated by dividing airport data on monthly passengers by scheduled seat departures for that month. Day-of-the-week data should be collected from the airlines if possible, but default day-of-week load factor adjustment ratios are provided in Appendix C if that is not possible.

Once the passenger level for each day in the base year is estimated, the days can be sorted, and the passenger level that corresponds to the user definition of design day (5 percent, 10 percent, etc.) becomes the design day passenger level.

The same process can be used to estimate enplaning, deplaning, or total passenger design day levels. Also, if the ratio of originating passengers to total passengers is known, design day O&D levels can be estimated.

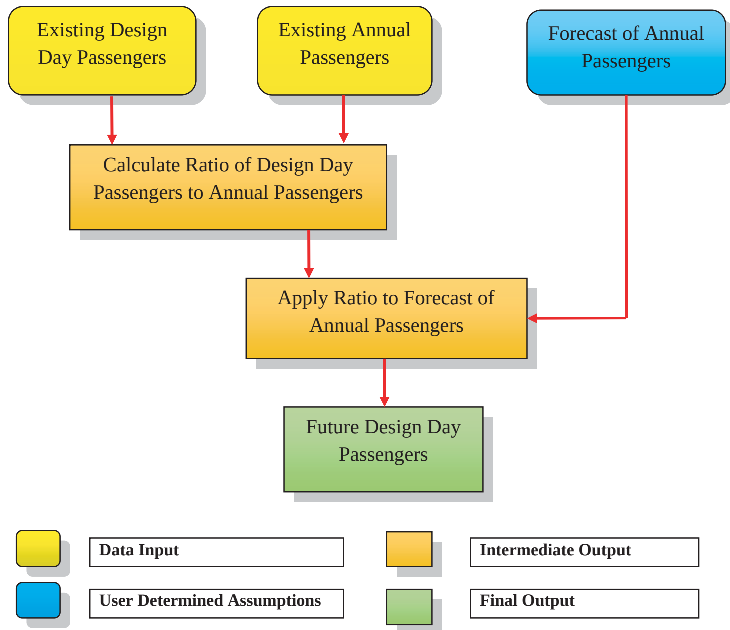
4.2.2 Future Design Day Passengers

Exhibit 4.7 provides an approach for estimating future design day levels that is very similar to the approach for estimating future design day aircraft operation levels.

4.2.3 Use of Toolbox

The passenger module of the Toolbox provides a quick method of estimating design day passengers. Sample Problem 4.2 shows how to use the Toolbox to calculate design day passengers.

Exhibit 4.7. Process for estimating future design day passengers.



Sample Problem 4.2

Problem Statement: Estimate Automobile Parking Requirements
Airport: Large Passenger Airport in Pacific Time Zone
Planning Factor: Parking Spaces per Design Day Passenger
Forecast Element: Design Day Passengers
Toolbox Module: Passenger

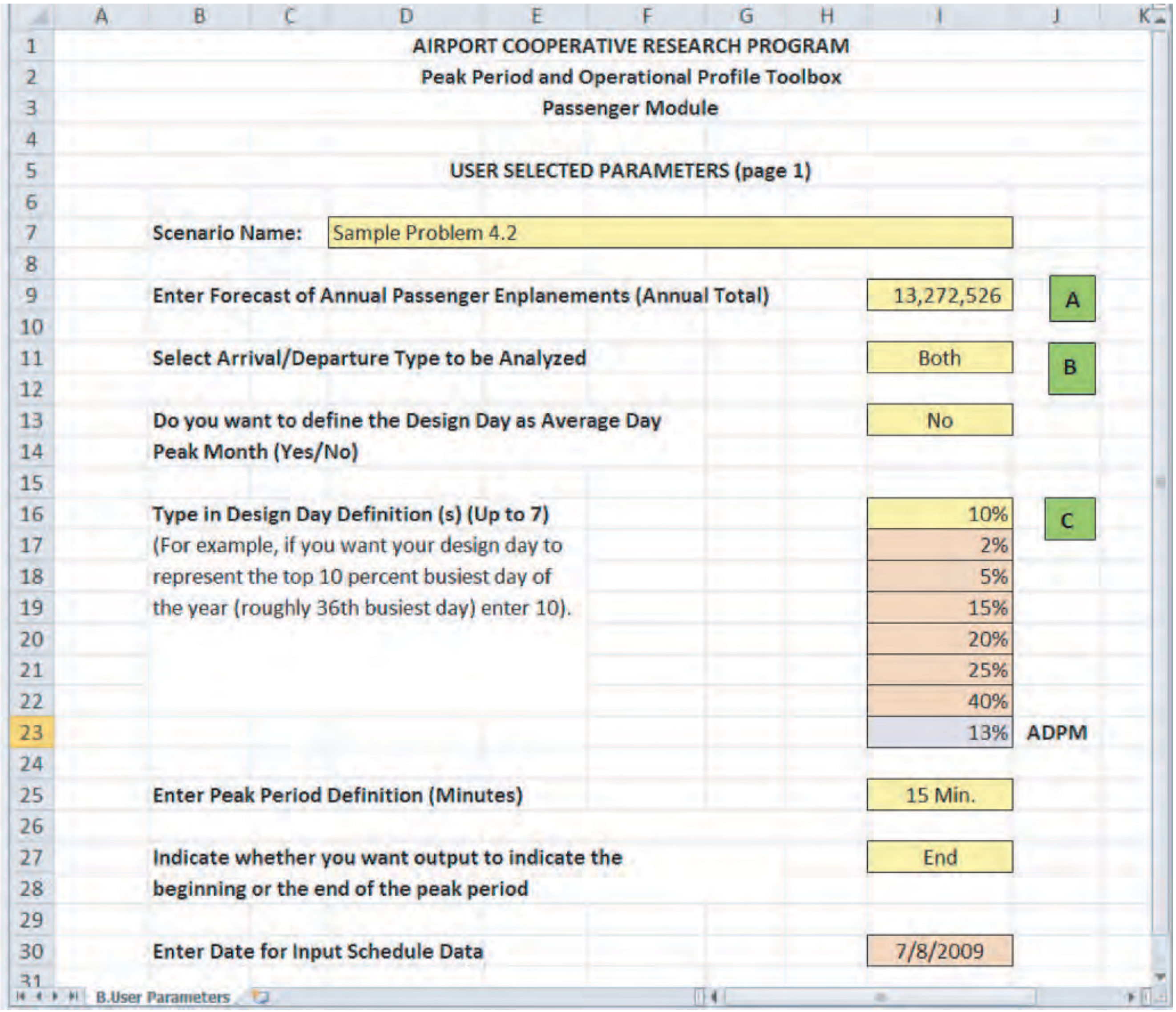
In Sample Problem 4.2, an airport planner needs to estimate automobile parking requirements for 2025. The planner wants to ensure the parking capacity is adequate for 90 percent of the time. From a previous analysis specific to the planner's airport, the planner also knows that 0.26 on-airport parking spaces must be provided for each design day O&D passenger. Inputs are provided for the 2025 annual passenger enplanements (A), arrival/departure designation (B), and design day definition (C) as shown below in the *B. User Parameters* worksheet (Exhibit 4.8). The planner chooses a 10 percent definition for design day, but includes several other definitions in the analysis to determine how much the design day definition will affect his answer.

The planner also adds data on enplanements by month (D), and estimates day-of-week load factor adjustments (E) from Appendix C as shown in Exhibit 4.9.

The final input parameters are the O&D selection (F) and the ratio of originations to enplanements (G) as shown in Exhibit 4.10. Peak period definitions and lead and lag factors are not required to estimate design day passengers so those inputs can be left blank.

The airport planner then adds scheduled seat arrivals and departures by day for the base year in the *C. Base Year Data* worksheet (Exhibit 4.11). The Schedule Data for Representative Day can be left blank since it isn't required to calculate design day passengers.

Exhibit 4.8. User parameter worksheet.



AIRPORT COOPERATIVE RESEARCH PROGRAM	
Peak Period and Operational Profile Toolbox	
Passenger Module	
USER SELECTED PARAMETERS (page 1)	
Scenario Name:	Sample Problem 4.2
Enter Forecast of Annual Passenger Enplanements (Annual Total)	13,272,526 (A)
Select Arrival/Departure Type to be Analyzed	Both (B)
Do you want to define the Design Day as Average Day Peak Month (Yes/No)	No
Type in 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).	10% (C)
	2%
	5%
	15%
	20%
	25%
	40%
	13% ADPM
Enter Peak Period Definition (Minutes)	15 Min.
Indicate whether you want output to indicate the beginning or the end of the peak period	End
Enter Date for Input Schedule Data	7/8/2009

B.User Parameters

The design day passenger forecast is provided in the *D. Design Day* worksheet (Exhibit 4.12). As shown, projected design day O&D passengers are 86,639. With a planning factor of 0.26 parking spaces per design day O&D passenger, this translates to a parking requirement of approximately 22,500 parking spaces. He notes that design day O&D passengers at the two and five percent levels are not much higher than at the 10 percent level, and therefore feels confident that overflow demand on days that exceed the 10 percent threshold will not be extreme.

4.3 Average Annual Day

For some analyses, such as noise analyses, the design day is defined as the AAD. To estimate AAD activity, divide annual operations by 365 days to obtain AAD operations and divide annual passengers to obtain AAD passengers. This approach works for both current and future year AAD estimates. Both the Operations and Passenger Modules provide estimates of the AAD in the *D. Design Day* worksheets.

Exhibit 4.9. Data on enplanement by month.

Enter Monthly Enplanements for Base Year (Each Month) D

Monthly Enplanements		
Jan.	1	523,455
Feb.	2	507,521
Mar.	3	703,822
Apr.	4	683,407
May	5	745,325
Jun.	6	852,200
Jul.	7	867,072
Aug.	8	882,504
Sep.	9	651,854
Oct.	10	623,708
Nov.	11	675,204
Dec.	12	703,762
Total		8,419,834

Enter Day of Week Load Factor Adjustment Factor (Load Factor for Day)/(Average Load Factor for Week) E

Day of Week Load Factor		
Sun	1	1.021
Mon	2	1.019
Tue	3	0.966
Wed	4	0.971
Thu	5	1.005
Fri	6	1.025
Sat	7	0.981

Exhibit 4.10. User selected parameters.

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

USER SELECTED PARAMETERS (page 2)

Choose origin/destination passengers or all passengers? Origin/Dest. F

If origin/designation, type in ratio of originations to enplanements 0.95 G

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%)

Lead Time (Minutes)			<9:00 am	>9:00 am
0	to	10	0.0%	0.0%
11	to	20	0.0%	0.0%
21	to	30	0.0%	0.0%
31	to	40	0.0%	0.0%

Lag Time (Minutes)			
0	to	10	0%
11	to	20	0%
21	to	30	0%
31	to	40	0%

Exhibit 4.11. Best year data worksheet.

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

Base Year - Scheduled Seats by Day of the Year

MM/DD/YYYY	Arriving	Departing	Arriving + Departing
1/1/2009	29231	29180	58,411
1/2/2009	31834	31858	63,692
1/3/2009	29239	29226	58,465
1/4/2009	30262	29909	60,171
1/5/2009	31234	31040	62,274
1/6/2009	30699	30714	61,413
1/7/2009	30521	30670	61,191
1/8/2009	30837	30814	61,651
1/9/2009	30910	31116	62,026
1/10/2009	25653	25184	50,837
1/11/2009	28565	28677	57,242
1/12/2009	30608	30744	61,352
1/13/2009	30222	30245	60,467
1/14/2009	30322	30322	60,644
1/15/2009	30555	30555	61,110
1/16/2009	30675	30868	61,543

Exhibit 4.12. Design day worksheet.

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

DESIGN DAY PASSENGER ESTIMATES

Sample Problem 4.2
Arriving + Departing Passenger Count - Origin-Destination Passengers

Base Year

Design Day & Average Annual Day (AAD)

Selected top X % busiest day	Rank	Arriving + Departing Passenger Count	Corresponding Calendar Date
ADPM	47	54,463	8/11/2009
10%	36	54,974	8/16/2009
2%	7	57,169	6/5/2009
5%	18	56,423	7/31/2009
15%	54	53,840	7/12/2009
20%	73	52,352	7/28/2009
25%	91	48,323	5/11/2009
40%	146	45,209	5/12/2009

Arriving + Departing Passenger Count - Origin-Destination Passengers

Annual Total =	16,001,092
Average Annual Day (ADD) Total =	43,839

Forecast Year

Future Design Day & Average Annual Day (AAD)

Selected top X % busiest day	Rank	Arriving + Departing Passenger Count
ADPM	47	85,834
10%	36	86,639
2%	7	90,099
5%	18	88,923
15%	54	84,852
20%	73	82,506
25%	91	76,157
40%	146	71,249

Arriving + Departing Passenger Count - Origin-Destination Passengers

Annual Total =	25,217,799
Future Average Annual Day (ADD) Passengers =	69,090

ADPM: Average Day in Peak Month

Base Year Annual Passenger Enplanements	8,419,834
Forecast Year Annual Passenger Enplanements	13,272,526
Design Day Definition	10%

D. Design Day

4.4 Comments and Cautions

When preparing design day estimates the following caution should be noted:

- The monthly and day-of-week load factors are based on averages and may not accurately represent absolute peaks, such as those that occur around major holidays. Therefore, results for passenger design day definitions representing the top one or two percent levels should be viewed with caution. As a cross-check for representing an absolute worst case, scheduled seats for a holiday travel-day can be collected and a 100 percent load factor can be applied. This will over-represent the actual level of passenger activity but can serve as an effective upper limit.

CHAPTER 5

Preparation of Design Day Profiles

This chapter discusses how to use the Toolbox to calculate existing design day profiles of aircraft operations and passengers and provides guidance for estimating future profiles. This chapter includes sample problems and provides some comments and cautions on the use of the data.

Design day profiles are focused on the distribution of aircraft operations or passenger activity throughout the design day. They are useful when the level of analysis is more involved, especially for terminal building and landside analysis. Activity levels at different facilities lead and lag passenger enplanement or deplanement activity by differing amounts depending on the facility in question. Design day profiles permit facility-specific peaks to be estimated more accurately than by using simple peak activity estimates. These profiles can be prepared for either a design day or an AAD.

5.1 Operations

5.1.1 Existing Design Day Operations Profiles

An approach to estimating existing aircraft operation design day profiles is provided in Exhibit 5.1.

Methods of estimating design day operations are described in Chapter 4. The data input day is a representative day for which complete aircraft operations data, with arrival or departure times identified for each operation, can be obtained. The data input day need not be the same as the design day, since it can be adjusted to represent the design day. Potential sources include noise monitoring data, if collected by the Airport, or Enhanced Traffic Management System (ETMS) or Performance Data Analysis and Reporting System (PDARS) data from the FAA. The input schedule data is organized by hour or other time period and then scaled to represent the design day.

Exhibit 5.2 describes an approach for estimating future design day profiles of aircraft operations.

The calculation of future design day operations is discussed in Chapter 4. Those operations, in conjunction with the existing design day profile, can be used to estimate a future design day profile of aircraft operations, provided no peak spreading is expected. If peak spreading is anticipated, a peak spreading factor can be applied that lessens the magnitude of both the peaks and valleys in the design day profile, as typically occurs with busier airports. The peak spreading factor is based on the tendency of hourly activity at airports to converge towards the average activity level of an hour during an operational day. See Appendix H in the *ACRP WOD 14* for additional discussion.

Exhibit 5.1. Process for estimating existing design day profile of aircraft operations.

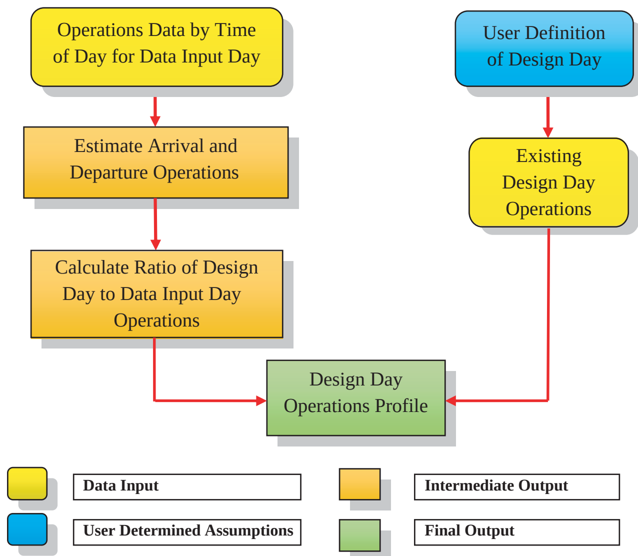
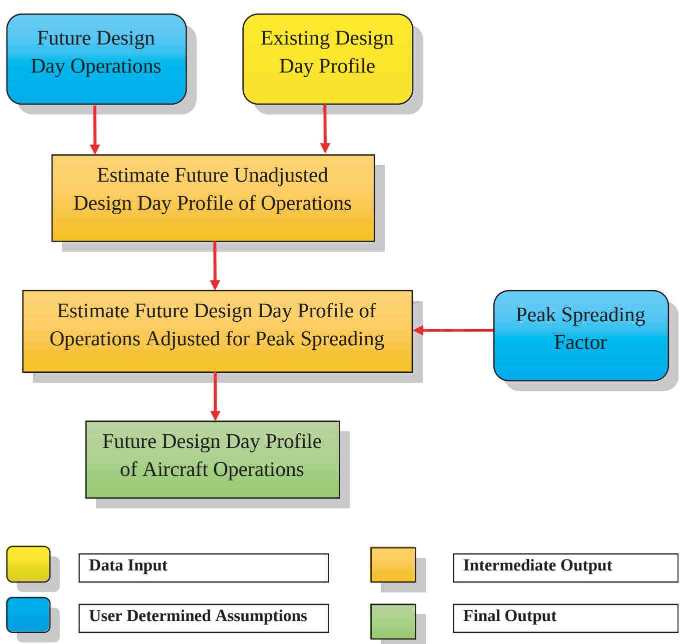


Exhibit 5.2. Process for estimating future design day profile of aircraft operations.



5.1.2 Use of Toolbox

The operations module of the Toolbox provides a quick method of estimating a future profile of design day operations. The following sample problem shows how to use the Toolbox to calculate a forecast profile of design day operations.

Sample Problem 5.1

Problem Statement: Validate Design Day Flight Schedule prepared by planning consultant

Airport: Large Commercial Airport in Mountain Time Zone

Forecast Element: Design Day Profile of Operations

Toolbox Module: Operations

In this instance, an airport planner needs to review a forecasted design day schedule prepared by a consultant. The consultant has assured the planner that the schedule incorporates a reasonable amount of peak spreading to ensure that future capacity issues are not overstated. The planner needs an independent crosscheck of this assumption and uses the Toolbox to prepare a design day profile that incorporates peak spreading as a benchmark to test the design day schedule.

The airport planner wants to check peak spreading for both arriving and departing operations and therefore runs the Toolbox twice, once in arrival mode and once in departure mode. The example in Exhibit 5.3 shows arrival mode (A). The planner also inputs the forecast of annual operations for the year (B) and the design day definition (10 percent in this case) (C). The peak period definition, and begin/end time designation (D) can be ignored since no peak period analysis is required for this effort.

The airport planner then moves to the *C. Base Year Data* worksheet and imports arrivals and departures by day of the year and arriving and departing operations by time of day for a representative day (see Exhibit 5.4). In this instance, operations by day of the year were obtained from the FAA's ETMS database and the schedule data for the representative day were obtained from the Airport's Noise and Operations Monitoring System (see Appendix B for more detail on data sources).

The *F. Design Day Profile* spread worksheet provides the forecasted design day profile incorporating peak spreading. The outputs for both arrivals and departures are provided in Exhibits 5.5 and 5.6.

With the above output the planner can proceed with evaluating the forecasted gated flight schedule, paying particularly close attention to the arrival peak hour, which occurs at 20:00–20:59 (8:00–8:59 PM) and falls from 9.8 percent to 9.1 percent of the total. The planner also closely examines the departure peak hour which occurs at 17:00–17:59 (5:00–5:59 PM) and falls from 9.0 percent to 8.5 percent of the total.

5.2 Design Day Passenger Profiles

5.2.1 Existing Design Day Passenger Profiles

The general approach to estimating existing passenger profiles is similar to the approach for estimating aircraft operation profiles. Since hourly data on passenger levels is typically unavailable, additional steps are required for the estimate. Exhibit 5.7 shows an approach for estimating existing design day passenger profiles.

Exhibit 5.3. Aircraft operations mode.

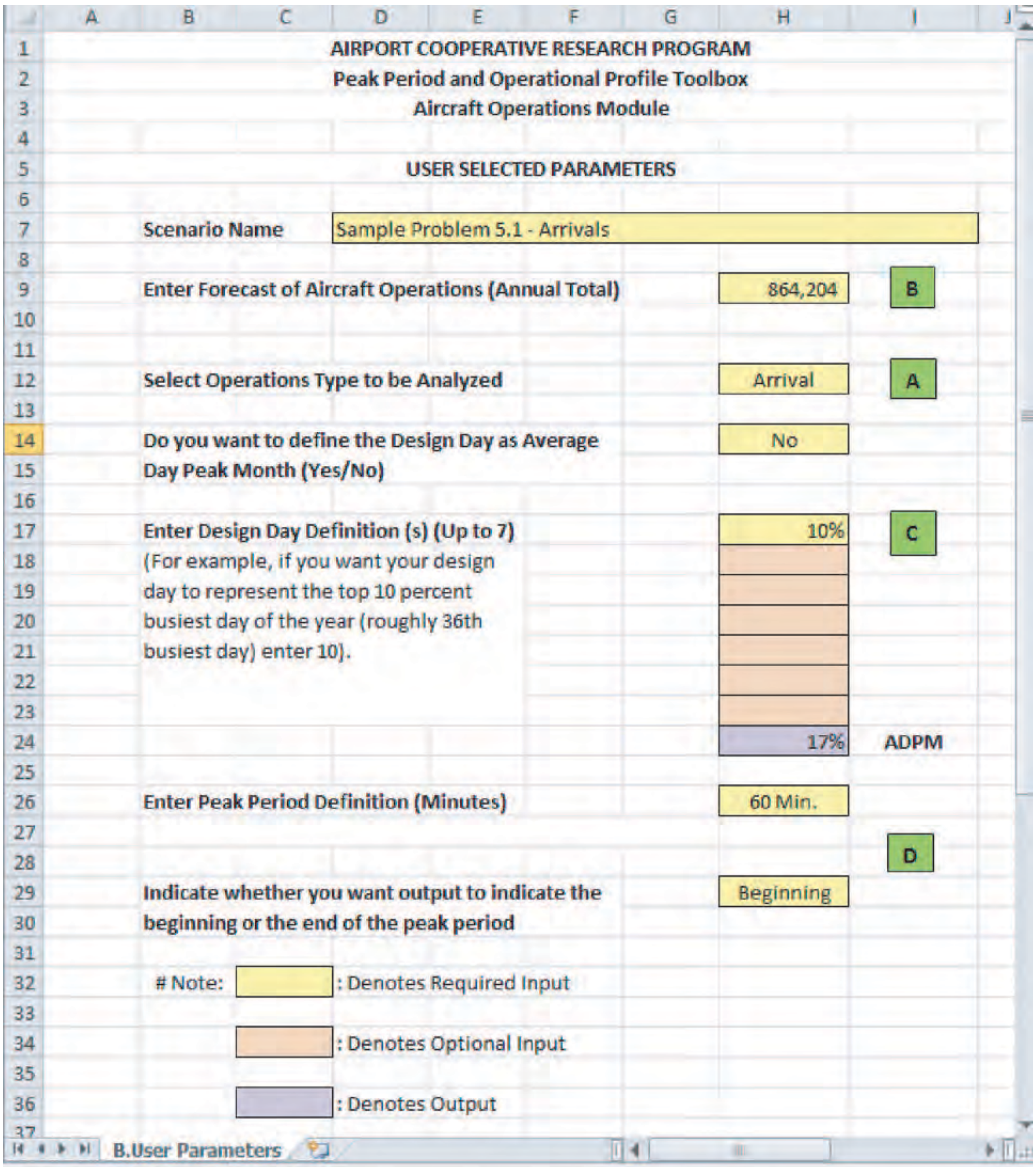


Exhibit 5.4. Base year data.

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
12:12 AM	D	C	B737	1/1/2009	786	789	1575
12:24 AM	A	C	B737	1/2/2009	886	888	1774
12:24 AM	D	C	A320	1/3/2009	802	803	1605
12:40 AM	D	C	B752	1/4/2009	841	845	1686
12:37 AM	D	T	E120	1/5/2009	862	864	1726
12:44 AM	D	C	A319	1/6/2009	852	855	1707
12:47 AM	D	C	A320	1/7/2009	841	841	1682
1:23 AM	D	C	A319	1/8/2009	852	853	1705
1:26 AM	D	C	B752	1/9/2009	849	850	1699
2:59 AM	A	C	B752	1/10/2009	701	704	1405
3:36 AM	A	C	A306	1/11/2009	767	768	1535
3:44 AM	A	T	SW4	1/12/2009	802	805	1607
3:59 AM	A	C	A306	1/13/2009	838	840	1678
4:20 AM	A	C	A306	1/14/2009	827	840	1667
4:29 AM	A	C	MD11	1/15/2009	842	844	1686
4:23 AM	D	C	B752	1/16/2009	851	854	1705
4:46 AM	A	T	SW4	1/17/2009	702	704	1406
4:48 AM	A	C	DC10	1/18/2009	769	772	1541
5:07 AM	A	P	PA31	1/19/2009	832	834	1666
5:20 AM	D	C	A306	1/20/2009	834	838	1672

C.Base Year data

To estimate design day passenger profiles, the user must provide design day passenger levels (see Chapter 4) and a distribution of scheduled seat arrivals and departures from the OAG (see Appendix B for detail on data sources). Ideally the OAG distribution of seat arrivals and departures would be obtained from the date corresponding to the existing design day identified from the design day analysis (Chapter 4). Referring back to Sample Problem 4.2 in Chapter 4, the user selected the 10 percent threshold to represent the design day, and the *D. Design Day* worksheet (see Exhibit 4.12) identified August 16, 2009 as representing the design day in the base year. Therefore, an OAG schedule for August 16, 2009 should be selected for the design day profile analysis in this case; however, the Toolbox is designed to adjust seat distributions from alternative days if data for the specific design day are not available.

Once the design day schedule information is entered, the average load factor for the data input day is then applied to the scheduled seat arrivals and departures to generate passenger distributions by time of day, which are then scaled so that the daily sum matches design day passenger levels. If reliable data on load factor distributions by time of day are available, the design day profile can be further defined (See Appendix E in *ACRP WOD 14* for additional discussion).

The design day passenger profile can be converted to a design day O&D passenger profile by applying a ratio of originations to enplanements. When planning for facilities driven by local

Exhibit 5.5. Design day profile: arrivals.

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

DESIGN DAY PROFILE ESTIMATES
(Assumes Peak Spreading)
Sample Problem 5.1 - Arrivals

Base Year

Design Day Profile

Arrivals

Hour	Op Count by Hour Bucket (Whole Day)	%
00:00-00:59	1	0.1%
01:00-01:59	-	0.0%
02:00-02:59	1	0.1%
03:00-03:59	3	0.3%
04:00-04:59	4	0.4%
05:00-05:59	4	0.4%
06:00-06:59	14	1.5%
07:00-07:59	68	7.4%
08:00-08:59	46	5.0%
09:00-09:59	85	9.3%
10:00-10:59	74	8.1%
11:00-11:59	50	5.4%
12:00-12:59	45	4.9%
13:00-13:59	44	4.8%
14:00-14:59	63	6.9%
15:00-15:59	40	4.4%
16:00-16:59	62	6.8%
17:00-17:59	86	9.4%
18:00-18:59	46	5.0%
19:00-19:59	47	5.1%
20:00-20:59	90	9.8%
21:00-21:59	23	2.5%
22:00-22:59	9	1.0%
23:00-23:59	13	1.4%
Total:	913	100.0%

Arrivals

Peak Value:	90	20:00
Peak Hour:	20:00-20:59	9.8%

Forecast Year (w/ Peak Spreading)

Future Design Day Profile

Arrivals

Hour	Op Count by Hour Bucket (Whole Day)	%
00:00-00:59	8	0.6%
01:00-01:59	-	0.0%
02:00-02:59	8	0.6%
03:00-03:59	11	0.8%
04:00-04:59	12	0.9%
05:00-05:59	12	0.9%
06:00-06:59	24	1.9%
07:00-07:59	91	7.0%
08:00-08:59	64	4.9%
09:00-09:59	112	8.7%
10:00-10:59	98	7.6%
11:00-11:59	69	5.3%
12:00-12:59	62	4.8%
13:00-13:59	61	4.7%
14:00-14:59	85	6.6%
15:00-15:59	56	4.4%
16:00-16:59	83	6.5%
17:00-17:59	113	8.8%
18:00-18:59	64	4.9%
19:00-19:59	65	5.0%
20:00-20:59	118	9.1%
21:00-21:59	35	2.7%
22:00-22:59	18	1.4%
23:00-23:59	23	1.8%
Total:	1,291	100.0%

Arrivals

Peak Value:	118	20:00
Peak Hour:	20:00-20:59	9.1%

Base Year Annual Operations	611,888
Forecast Year Annual Operations	864,204
Design Day Definition	10%

F. Design Day Profile - Spread

Exhibit 5.6. Design day profile: departures.

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

DESIGN DAY PROFILE ESTIMATES
(Assumes Peak Spreading)
Sample Problem 5.1 - Departures

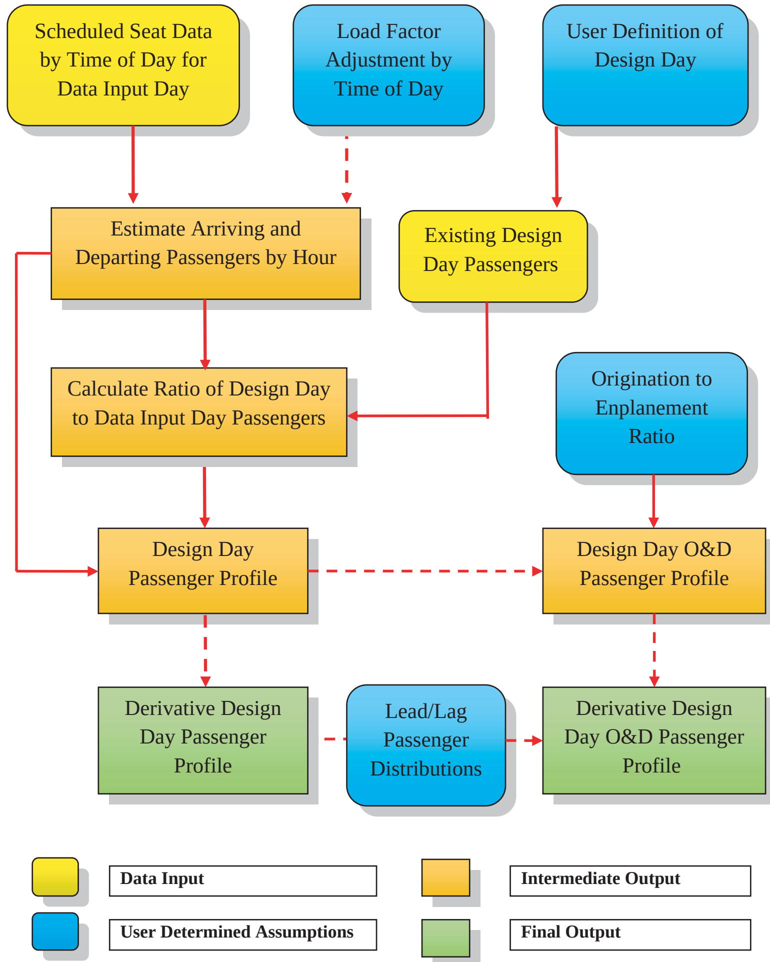
Base Year			Forecast Year (w/ Peak Spreading)		
Design Day Profile			**Future Design Day Profile**		
Departures			**Departures**		
Hour	Op Count by Hour Bucket (Whole Day)	%	Hour	Op Count by Hour Bucket (Whole Day)	%
00:00-00:59	6	0.6%	00:00-00:59	14	1.1%
01:00-01:59	2	0.2%	01:00-01:59	9	0.7%
02:00-02:59	-	0.0%	02:00-02:59	-	0.0%
03:00-03:59	-	0.0%	03:00-03:59	-	0.0%
04:00-04:59	1	0.1%	04:00-04:59	8	0.6%
05:00-05:59	3	0.3%	05:00-05:59	11	0.8%
06:00-06:59	37	4.0%	06:00-06:59	52	4.1%
07:00-07:59	30	3.2%	07:00-07:59	44	3.4%
08:00-08:59	69	7.6%	08:00-08:59	93	7.2%
09:00-09:59	39	4.2%	09:00-09:59	55	4.3%
10:00-10:59	82	9.0%	10:00-10:59	109	8.5%
11:00-11:59	78	8.5%	11:00-11:59	104	8.1%
12:00-12:59	68	7.5%	12:00-12:59	92	7.1%
13:00-13:59	42	4.5%	13:00-13:59	59	4.5%
14:00-14:59	38	4.1%	14:00-14:59	54	4.2%
15:00-15:59	66	7.3%	15:00-15:59	89	6.9%
16:00-16:59	40	4.3%	16:00-16:59	56	4.4%
17:00-17:59	41	4.4%	17:00-17:59	57	4.4%
18:00-18:59	66	7.3%	18:00-18:59	89	6.9%
19:00-19:59	72	7.9%	19:00-19:59	97	7.5%
20:00-20:59	34	3.7%	20:00-20:59	49	3.8%
21:00-21:59	77	8.4%	21:00-21:59	103	8.0%
22:00-22:59	24	2.6%	22:00-22:59	36	2.8%
23:00-23:59	1	0.1%	23:00-23:59	8	0.6%
Total:	914	100.0%	Total:	1,290	100.0%

Departures			Departures		
Peak Value:	82	10:00	Peak Value:	109	10:00
Peak Hour:	10:00-10:59	9.0%	Peak Hour:	10:00-10:59	8.5%

Base Year Annual Operations	**611,888**
Forecast Year Annual Operations	**864,204**
Design Day Definition	**10%**

F. Design Day Profile - Spread

Exhibit 5.7. Process for estimating existing design day passenger profile.



(O&D) passenger demand such as security, check-in, baggage claim, parking, and roadways, additional refinements to estimate design day profiles of O&D demand may be required. Absent data from the airline, the following approaches can be used to refine estimates of the O&D share of total passengers by hour:

- Segregate the passenger data by airline and then estimate hourly O&D traffic for each airline. This way, hours that are dominated by airlines that do not provide connecting service will reflect the high O&D share that characterizes these airlines.
- If there are no redeye flights, flights that depart prior to the first arrival bank will have virtually no connecting traffic. Flights that arrive after the last departing bank will likewise have virtually no connecting traffic.
- If the design day profile is derived from a design day schedule, additional market variations in O&D shares can be incorporated. See Section 6.3 for additional detail.
- At "spoke" airports where virtually all passenger traffic is O&D, local passenger traffic will essentially be the same as enplaning and deplaning traffic, and the passenger and O&D passenger design day profiles will be very similar.

As noted in Chapter 2, the peak passenger impact on many terminal and landside facilities occurs at a different time than the enplanement and deplanement peaks. Enplaning passengers will stress these facilities for a period of time prior to scheduled aircraft departure while deplaning passengers will stress 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. If estimates of these distributions are available, derivative design day passenger profiles tailored to each facility can be estimated from the original design day passenger profile.

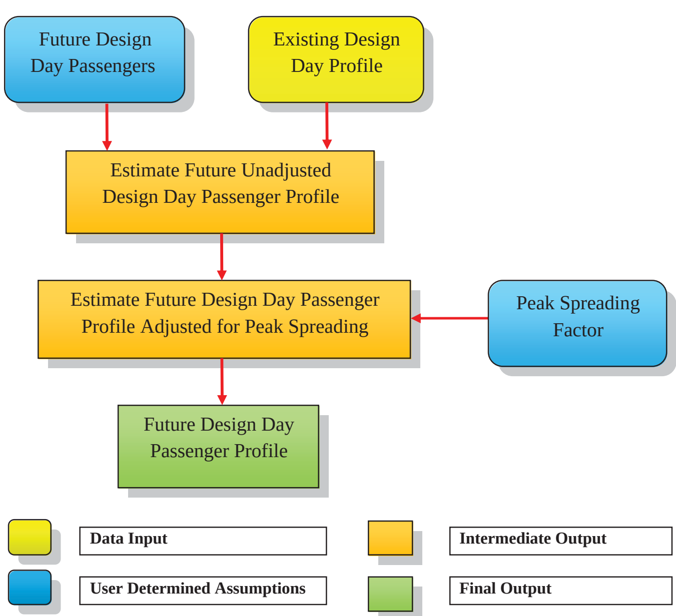
5.2.2 Forecast Design Day Passenger Profiles

Exhibit 5.8 shows an approach for estimating future design day passenger profiles. The process can be used to estimate future design day passenger profiles, O&D passenger profiles, and derivative passenger profiles. The calculation of future design day passengers is discussed in Chapter 4. Those passenger projections, in conjunction with the existing design day profile, can be used to estimate a future design day profile of aircraft operations, provided no peak spreading is expected. If peak spreading is anticipated, a peak spreading factor can be applied that reduces the magnitude of both the peaks and valleys in the design day profile, as typically occurs with busier airports. The peak spreading factor is based on the tendency of hourly activity at airports to converge towards the average activity level of an hour during an operational day. See Appendix H in the *ACRP WOD 14* for additional discussion.

5.2.3 Use of the Toolbox

The passenger module of the Toolbox provides a quick method of estimating a future profile of design day passengers. The following sample problem shows how to use the Toolbox to calculate a derivative design day passenger profile.

Exhibit 5.8. Process for estimating future design day passenger profile.



Sample Problem 5.2

Problem Statement: Estimate future daily distribution of airport-related vehicular traffic for air quality dispersion analysis.

Airport: Large Commercial Airport in Pacific Time Zone

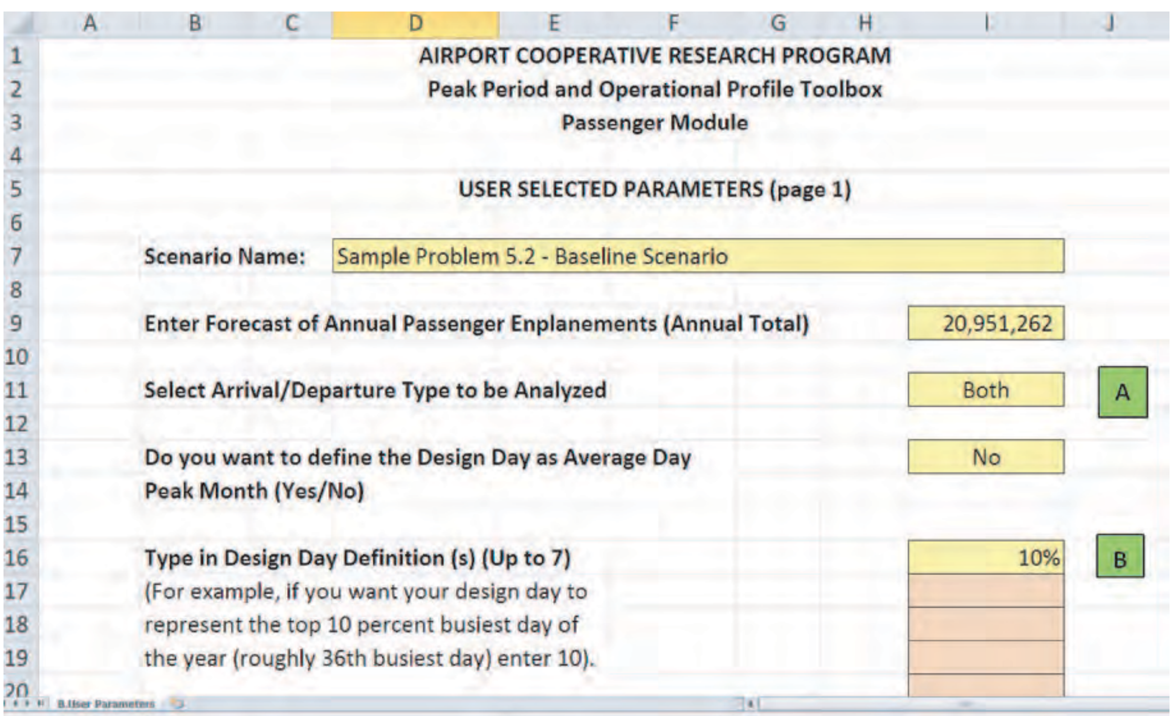
Forecast Element: Derivative Design Day O&D Passenger Profile

Toolbox Module: Passenger

In this case, an environmental planner needs to quickly estimate future airport vehicular traffic for air quality dispersion analysis. After coordination between the planner, the FAA, and local air agency, it was agreed that because the pollutant of concern focused on the frequency that an air quality standard is exceeded, a dispersion analysis would be conducted for the design day of the facility. The planner knows that O&D passengers are the primary determinant of airport related vehicular traffic but also knows that departing passengers arrive at the airport well before their flight leaves and that there is also a lag between the time an aircraft arrives and the deplaning passenger leaves the airport. Therefore, airline schedules by themselves are not an accurate determinant of the hourly distribution of vehicular traffic. The Toolbox is used to generate a derivative design day profile that reflects the differences in the hourly distribution of activity at the airport roadways versus the airport gates.

The planner goes to the *B. User Parameters* worksheet and enters data for forecast annual passengers (see Exhibit 5.9). Since the planner is interested in both arriving and departing

Exhibit 5.9. User parameters worksheet.


AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

USER SELECTED PARAMETERS (page 1)

Scenario Name: Sample Problem 5.2 - Baseline Scenario

Enter Forecast of Annual Passenger Enplanements (Annual Total) 20,951,262

Select Arrival/Departure Type to be Analyzed Both A

Do you want to define the Design Day as Average Day Peak Month (Yes/No) No

Type in Design Day Definition (s) (Up to 7) 10% B
(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).

passengers, "both" is selected from the drop down menu (A) when selecting between arriving/departure type. After consultation with relevant agencies, the 10 percent busiest day is decided as an appropriate busy day for the air quality analysis. Therefore, the Design Day is not defined as the Average Day of the Peak Month and a 10 percent definition is selected instead (B).

Since peak period information is not needed, the peak period input parameters are skipped, but the planner provides data on average monthly enplanements (C) and day-of-the-week load factor adjustments (D) from Appendix C (see Exhibit 5.10). Since connecting passengers don't generate ground vehicle trips, the planner specifies that the Toolbox is to calculate O&D traffic (E) which accounts for 75 percent of total passenger traffic (F) at her airport. Finally, the planner incorporates the lead (G) and lag (H) distributions from a recent passenger survey conducted by the airport (see Exhibit 5.11).

The planner moves on to the Base Year Data worksheet (Exhibit 5.12) and provides OAG schedule data by flight for a representative day, and scheduled seat arrivals and departures for each day of the year as shown previously.

The environmental planner believes the airport will experience an average amount of peak spreading, and therefore moves past worksheet *F. Derivative Profile—NS,* which shows the derivative O&D passenger distribution without peak spreading and looks to worksheet *H. Derivative Profile—PS* (Exhibit 5.13), which does incorporate peak spreading, for results.

Using ratios of passengers to vehicle trips obtained from a previous airport survey, the planner now has the information needed to generate an hourly distribution of airport-related vehicle trips. It's noted that the derivative peak hour occurs at 11:00 AM and is projected to account for 7.6 percent of daily activity. In passing, a glance at the non-derivative design day profile [*G. Design Day Profile—PS* worksheet (not shown)] shows that the airside peak hour occurs at 12:00 PM and only accounts for 6.8 percent of design day activity. Without accounting for the different distributions of landside and airside activity, the planner would have underestimated the landside peak.

Exhibit 5.10. User parameter worksheet: enplanements and load factors.

Enter Monthly Enplanements for Base Year (Each Month) C

Monthly Enplanements		
Jan.	1	1,104,562
Feb.	2	1,088,207
Mar.	3	1,268,333
Apr.	4	1,213,743
May	5	1,305,825
Jun.	6	1,443,900
Jul.	7	1,477,906
Aug.	8	1,432,620
Sep.	9	1,077,823
Oct.	10	1,126,432
Nov.	11	1,185,607
Dec.	12	1,186,352
Total		14,911,310

Enter Day of Week Load Factor Adjustment Factor (Load Factor for Day)/(Average Load Factor for Week) D

Day of Week Load Factor		
Sun	1	1.031
Mon	2	1.017
Tue	3	0.966
Wed	4	0.971
Thu	5	1.005
Fri	6	1.025
Sat	7	0.981

Exhibit 5.11. User parameter worksheet: lead and lag distribution.

USER SELECTED PARAMETERS (page 2)

Choose origin/destination passengers or all passengers? Origin/Dest. E

If origin/designation, type in ratio of originations to enplanements 0.75 F

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%)

G

Lead Time (Minutes)			<9:00 am	>9:00 am
0	to	10	0.0%	0.0%
11	to	20	0.0%	0.0%
21	to	30	5.0%	1.0%
31	to	40	10.0%	5.0%
41	to	50	20.0%	10.0%
51	to	60	20.0%	20.0%
61	to	70	20.0%	20.0%
71	to	80	15.0%	15.0%
81	to	90	5.0%	12.0%
91	to	100	3.0%	8.0%
101	to	110	1.0%	5.0%
111	to	120	1.0%	3.0%
121	to	130	0.0%	1.0%
		Total:	100.0%	100.0%

H

Lag Time (Minutes)			
0	to	10	1%
11	to	20	5%
21	to	30	35%
31	to	40	10%
41	to	50	10%
51	to	60	25%
61	to	70	10%
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%

B.User Parameters

Exhibit 5.12. Base year data worksheet.

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
12:09 AM	172	A	P	739
12:22 AM	182	A	P	752
12:45 AM	258	A	P	A343
12:47 AM	144	A	P	734
12:50 AM	157	A	P	738
12:55 AM	160	A	P	73H
1:13 AM	155	A	P	738
2:44 AM	126	A	P	A319
2:52 AM	144	A	P	734
4:15 AM	144	A	P	734
4:54 AM	216	A	P	753
4:54 AM	172	A	P	739
5:31 AM	224	A	P	753
5:33 AM	140	A	P	MD80

Base Year - Scheduled Seats by Day of the Year

MM/DD/YYYY	Arriving	Departing	Arriving + Departing
1/1/2009	29,231	29,180	58,411
1/2/2009	31,834	31,858	63,692
1/3/2009	29,239	29,226	58,465
1/4/2009	30,262	29,909	60,171
1/5/2009	31,234	31,040	62,274
1/6/2009	30,699	30,714	61,413
1/7/2009	30,521	30,670	61,191
1/8/2009	30,837	30,814	61,651
1/9/2009	30,910	31,116	62,026
1/10/2009	25,653	25,184	50,837
1/11/2009	28,565	28,677	57,242
1/12/2009	30,608	30,744	61,352
1/13/2009	30,222	30,245	60,467
1/14/2009	30,322	30,322	60,644

C.Base Year Data

Exhibit 5.13. Derivative profile worksheet.

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

DESIGN DAY DERIVATIVE PROFILE ESTIMATES
(Assumes Peak Spreading)

Sample Problem 5.2 - Baseline Scenario
Arriving + Departing Passenger Count - Origin-Destination 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	1,051	1.4%	00:00-00:59	1,824	1.8%
01:00-01:59	749	1.0%	01:00-01:59	1,452	1.4%
02:00-02:59	73	0.1%	02:00-02:59	620	0.6%
03:00-03:59	175	0.2%	03:00-03:59	745	0.7%
04:00-04:59	1,088	1.5%	04:00-04:59	1,869	1.8%
05:00-05:59	2,491	3.4%	05:00-05:59	3,596	3.5%
06:00-06:59	3,388	4.6%	06:00-06:59	4,700	4.6%
07:00-07:59	3,540	4.8%	07:00-07:59	4,888	4.8%
08:00-08:59	3,021	4.1%	08:00-08:59	4,248	4.1%
09:00-09:59	3,394	4.6%	09:00-09:59	4,707	4.6%
10:00-10:59	4,633	6.3%	10:00-10:59	6,233	6.1%
11:00-11:59	5,942	8.1%	11:00-11:59	7,844	7.6%
12:00-12:59	4,543	6.2%	12:00-12:59	6,122	6.0%
13:00-13:59	4,126	5.6%	13:00-13:59	5,608	5.5%
14:00-14:59	3,731	5.1%	14:00-14:59	5,123	5.0%
15:00-15:59	3,660	5.0%	15:00-15:59	5,035	4.9%
16:00-16:59	3,587	4.9%	16:00-16:59	4,945	4.8%
17:00-17:59	4,091	5.6%	17:00-17:59	5,565	5.4%
18:00-18:59	3,262	4.5%	18:00-18:59	4,545	4.4%
19:00-19:59	3,526	4.8%	19:00-19:59	4,870	4.7%
20:00-20:59	3,124	4.3%	20:00-20:59	4,376	4.3%
21:00-21:59	4,226	5.8%	21:00-21:59	5,731	5.6%
22:00-22:59	3,394	4.6%	22:00-22:59	4,708	4.6%
23:00-23:59	2,357	3.2%	23:00-23:59	3,431	3.3%
Total:	73,170	100.0%	Total:	102,786	100.0%

Peak Value:	5,942	11:00	Peak Value:	7,844	11:00
Peak Hour:	11:00-11:59	8.12%	Peak Hour:	11:00-11:59	7.63%

Base Year Annual Passenger Enplanements	14,911,310
Forecast Year Annual Passenger Enplanements	20,951,262
Design Day Definition	10%

H.Derivative Profile - PS

Exhibit 5.14. Lead distribution scenario.

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%)

Lead Time (Minutes)			<9:00 am	>9:00 am
0	to	10	0.0%	0.0%
11	to	20	15.0%	10.0%
21	to	30	40.0%	30.0%
31	to	40	40.0%	30.0%
41	to	50	3.0%	20.0%
51	to	60	2.0%	10.0%
61	to	70	0.0%	0.0%
71	to	80	0.0%	0.0%
81	to	90	0.0%	0.0%
91	to	100	0.0%	0.0%
101	to	110	0.0%	0.0%
111	to	120	0.0%	0.0%
121	to	130	0.0%	0.0%
		Total:	100.0%	100.0%

Lag Time (Minutes)			
0	to	10	1%
11	to	20	5%
21	to	30	35%
31	to	40	10%
41	to	50	10%
51	to	60	25%
61	to	70	10%
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%

After reviewing the analysis, the Airport Director asks whether a change in security procedures could affect the arrival distribution sufficiently to change the results. Since future security procedures and their impacts on arrival distributions are difficult to predict, the planner and the planner's staff meet and use their professional judgment to develop a wide range of potential lead distributions for scenario testing. The Toolbox allows them to quickly test each of the distribution scenarios.

They test many scenarios, two of which are illustrated here. Scenario A assumes the terrorism threat declines significantly and security procedures are streamlined to reflect the reduced threat. The assumed lead distribution for this scenario is shown in Exhibit 5.14 and the results are shown in Exhibit 5.15.

Scenario B assumes a much more stringent security environment that requires passengers to arrive much earlier than they do now. The assumed lead time distribution for this scenario is presented in Exhibit 5.16 and the results are presented in Exhibit 5.17.

Peak hour passenger O&D traffic at the curb ranges from 7,677 under Scenario A to 7,640 under Scenario B. These numbers compare to 7,844 with the baseline distributions. After examining the remaining scenario results, the planner reports to the Director that changes in security procedures are unlikely to materially change the peak hour impacts and in fact may reduce them slightly.

5.3 Comments and Cautions

When preparing design day profiles the following comments and cautions should be noted:

- If the data and resources are available, consider segmenting the categories when preparing forecasts of design day profiles. For example, domestic and international passengers have and

Exhibit 5.15. Lead distribution results.

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

DESIGN DAY DERIVATIVE PROFILE ESTIMATES
(Assumes Peak Spreading)

Sample Problem 5.2 - Scenario A
Arriving + Departing Passenger Count - Origin-Destination 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	1,074	1.5%	00:00-00:59	1,853	1.8%
01:00-01:59	890	1.2%	01:00-01:59	1,625	1.6%
02:00-02:59	73	0.1%	02:00-02:59	620	0.6%
03:00-03:59	146	0.2%	03:00-03:59	709	0.7%
04:00-04:59	156	0.2%	04:00-04:59	722	0.7%
05:00-05:59	2,106	2.9%	05:00-05:59	3,122	3.0%
06:00-06:59	3,433	4.7%	06:00-06:59	4,755	4.6%
07:00-07:59	3,287	4.5%	07:00-07:59	4,576	4.5%
08:00-08:59	3,538	4.8%	08:00-08:59	4,885	4.8%
09:00-09:59	3,094	4.2%	09:00-09:59	4,338	4.2%
10:00-10:59	4,278	5.8%	10:00-10:59	5,796	5.6%
11:00-11:59	5,806	7.9%	11:00-11:59	7,677	7.5%
12:00-12:59	5,557	7.6%	12:00-12:59	7,370	7.2%
13:00-13:59	3,457	4.7%	13:00-13:59	4,785	4.7%
14:00-14:59	4,222	5.8%	14:00-14:59	5,726	5.6%
15:00-15:59	3,567	4.9%	15:00-15:59	4,921	4.8%
16:00-16:59	3,509	4.8%	16:00-16:59	4,849	4.7%
17:00-17:59	4,195	5.7%	17:00-17:59	5,693	5.5%
18:00-18:59	3,502	4.8%	18:00-18:59	4,840	4.7%
19:00-19:59	3,496	4.8%	19:00-19:59	4,834	4.7%
20:00-20:59	3,434	4.7%	20:00-20:59	4,756	4.6%
21:00-21:59	3,903	5.3%	21:00-21:59	5,334	5.2%
22:00-22:59	3,897	5.3%	22:00-22:59	5,327	5.2%
23:00-23:59	2,552	3.5%	23:00-23:59	3,671	3.6%
Total:	73,170	100.0%	Total:	102,786	100.0%

Peak Value:	5,806	11:00	Peak Value:	7,677	11:00
Peak Hour:	11:00-11:59	7.93%	Peak Hour:	11:00-11:59	7.47%

Base Year Annual Passenger Enplanements	14,911,310
Forecast Year Annual Passenger Enplanements	20,951,262
Design Day Definition	10%

Exhibit 5.16. Assumed lead time distribution.

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%)

Lead Time (Minutes)			<9:00 am	>9:00 am
0	to	10	0.0%	0.0%
11	to	20	0.0%	0.0%
21	to	30	0.0%	0.0%
31	to	40	1.0%	0.0%
41	to	50	3.0%	2.0%
51	to	60	15.0%	5.0%
61	to	70	30.0%	15.0%
71	to	80	30.0%	20.0%
81	to	90	15.0%	20.0%
91	to	100	5.0%	15.0%
101	to	110	1.0%	10.0%
111	to	120	0.0%	8.0%
121	to	130	0.0%	5.0%
		Total:	100.0%	100.0%

Lag Time (Minutes)			
0	to	10	1%
11	to	20	5%
21	to	30	35%
31	to	40	10%
41	to	50	10%
51	to	60	25%
61	to	70	10%
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%

B.User Parameters

are expected to continue to grow at different rates. Moreover, international traffic, because of the more limited windows, has a very different and more pronounced profile than domestic traffic. When aggregated, categories with differing growth rates and differing profiles can result in a marked change in the overall profile.

- The Toolbox assumes the relationship between the number of total passengers and O&D passengers is the same throughout the day. In reality, the distribution of O&D traffic at airline connecting hubs will differ from the distribution of total passenger traffic. Data on the hourly distribution of local/connecting percentages is very scarce and would need to be obtained from the airlines. Approaches to estimating local/connecting percentages by time of day are provided in more detail in Section 6.3.
- Also note that it may be necessary to distinguish between resident and non-resident O&D traffic. This may have some relevance for terminal facilities, because resident passengers will likely be more familiar with the airport and have shorter lead times. 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.

Exhibit 5.17. Assumed lead time results.

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

DESIGN DAY DERIVATIVE PROFILE ESTIMATES
(Assumes Peak Spreading)

Sample Problem 5.2 - Scenario B
Arriving + Departing Passenger Count - Origin-Destination Passengers

Base Year: Design Day Derivative Profile			Forecast Year (w/ Peak Spreading): Future Design Day Derivative Profile		
Hour	Passengers by Hour	%	Hour	Passengers by Hour	After adjust (%)
00:00-00:59	1,092	1.5%	00:00-00:59	1,874	1.8%
01:00-01:59	636	0.9%	01:00-01:59	1,314	1.3%
02:00-02:59	73	0.1%	02:00-02:59	620	0.6%
03:00-03:59	185	0.3%	03:00-03:59	758	0.7%
04:00-04:59	1,609	2.2%	04:00-04:59	2,510	2.4%
05:00-05:59	2,614	3.6%	05:00-05:59	3,748	3.6%
06:00-06:59	3,277	4.5%	06:00-06:59	4,564	4.4%
07:00-07:59	3,664	5.0%	07:00-07:59	5,040	4.9%
08:00-08:59	2,813	3.8%	08:00-08:59	3,993	3.9%
09:00-09:59	3,533	4.8%	09:00-09:59	4,879	4.7%
10:00-10:59	4,855	6.6%	10:00-10:59	6,507	6.3%
11:00-11:59	5,776	7.9%	11:00-11:59	7,640	7.4%
12:00-12:59	4,413	6.0%	12:00-12:59	5,962	5.8%
13:00-13:59	4,121	5.6%	13:00-13:59	5,603	5.5%
14:00-14:59	3,611	4.9%	14:00-14:59	4,975	4.8%
15:00-15:59	3,791	5.2%	15:00-15:59	5,197	5.1%
16:00-16:59	3,638	5.0%	16:00-16:59	5,008	4.9%
17:00-17:59	3,905	5.3%	17:00-17:59	5,337	5.2%
18:00-18:59	3,177	4.3%	18:00-18:59	4,440	4.3%
19:00-19:59	3,522	4.8%	19:00-19:59	4,865	4.7%
20:00-20:59	3,135	4.3%	20:00-20:59	4,388	4.3%
21:00-21:59	4,194	5.7%	21:00-21:59	5,692	5.5%
22:00-22:59	3,140	4.3%	22:00-22:59	4,395	4.3%
23:00-23:59	2,395	3.3%	23:00-23:59	3,478	3.4%
Total:	73,170	100.0%	Total:	102,786	100.0%

Peak Value:	5,776	11:00	Peak Value:	7,640	11:00
Peak Hour:	11:00-11:59	7.89%	Peak Hour:	11:00-11:59	7.43%

Base Year Annual Passenger Enplanements	14,911,310
Forecast Year Annual Passenger Enplanements	20,951,262
Design Day Definition	10%

H.Derivative Profile - PS

CHAPTER 6

Preparation of Design Day Flight Schedules

This chapter provides guidance on the preparation of forecast flight schedules for use in simulation modeling and detailed terminal and landside analysis, as well as air quality analysis and detailed noise modeling.

6.1 Background

Design day flight schedules are more complex and take more time to prepare than design day profiles. Once complete, however, they can be used to derive future design day profiles, INM input files, and peak period activity forecasts. In addition, because they are constructed using a "bottom-up" individual flight basis, they can be manipulated according to virtually any criteria or category desired. Design day flight schedules are required for airfield or terminal simulation, and are very useful for detailed alternatives analysis, which would be required in evaluating terminal or concourse concepts that differ in size, configuration, or airline assignment. The format of these schedules depends on their intended use as shown in Exhibit 6.1. Note that air quality inventory analyses and INM noise analyses do not require a design day schedule as an input and are therefore not included in the Exhibit.

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 and the terminal airspace arrival and departure routes. 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 are important to this analysis since they help determine taxiway paths and the operational efficiency of the airport.

The airfield aspects of the flight schedule decline 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 for terminal planning. Exhibit 6.2 shows a sample page from a design day schedule prepared for terminal building analysis at a large west coast airport. The O&D passenger flows derived from design day schedules, once appropriate lead and lag times are applied, can be converted to vehicle trips and used as inputs for landside models.

The FAA uses these schedules for current and near term national airspace planning, where 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.[vii]

Exhibit 6.1. 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 focuses much of its modeling effort on the busiest airports because they generate the most delay. As a result, the FAA generates constrained design day schedules to avoid forecasting activity levels that cannot be supported by the current or projected airfield 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 which can be used to incorporate existing constraints into the preparation of gated flight schedules.[viii] See Chapter 9 for additional discussion on the application of constraints.

Air quality dispersion analysis using the EDMS and forthcoming AEDT models uses the output of simulation models such as SIMMOD or TAAM. Dispersion analysis therefore requires all the output required for airfield analysis to assess the air quality impacts of aircraft operations. To assess landside air quality impacts, these models require ground vehicle activity estimates, which are typically generated from the O&D output of the design day schedules.

The NIRS noise model requires data input on a flight-by-flight basis as provided in a design day schedule. Since the model focuses on evaluating aircraft noise characteristics, associated passenger data is not required.

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 how airlines balance various factors when planning future schedules. 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.

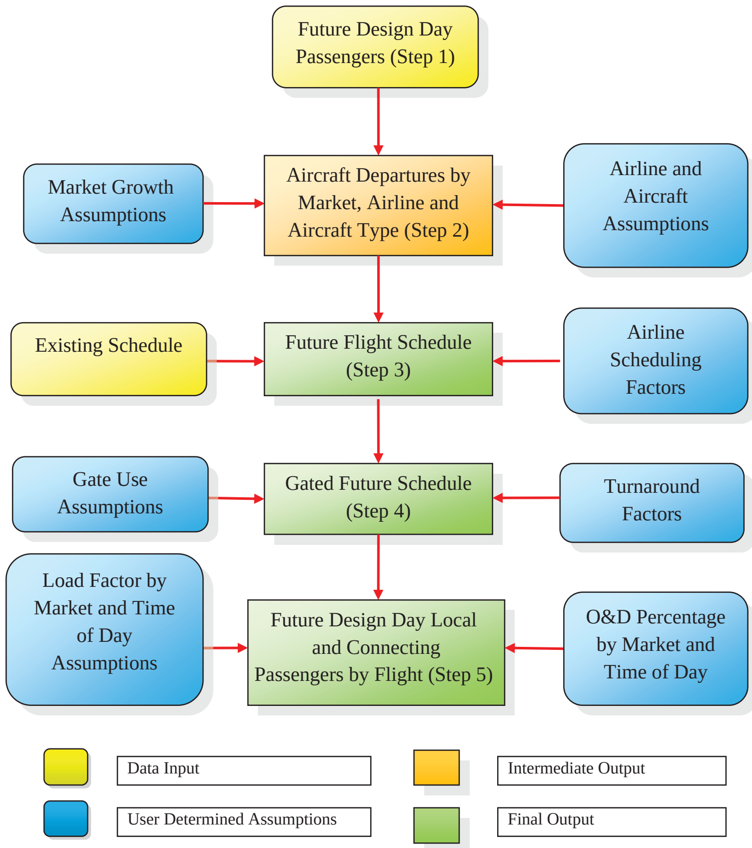
6.2 Preparation of Design Day Schedules

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 to allocate new routes, depending on the anticipated growth characteristics of the origin and destination airports.[ix] 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 time and budget are limited, existing flights are duplicated, with a random distribution factor applied to ensure that there is no exact match in flight times. This carries an assumption that the airport's future daily profile will essentially be the same as the existing daily profile and

Exhibit 6.2. Sample page from design day gated flight schedule for a large west coast airport.

Gated Flight Schedule With Preferential Gate Use- High Airfield - Constrained 2030 AAD Forecast Alternative 1 West Build-Out Option																													
			Arrivals														Departures												
Ref. Num.	Gate	Gate Type	TOW	Type D/I	Origin	Arr. Hour	Arr. Min.	PC	Air-line	Equip-ment	Seats	Arr. L.F.	Arr. OD %	Depl	Term	.	TOW	Type D/I	Dest.	Dept. Hour	Dept. Min.	PC	Air-line	Equip-ment	Seats	Dept. L.F.	Dept. OD %	Enp	Orig
1	1	NB				00	00	WN	WN	735	122							D	PHX	07	00	WN	WN	735	122	90%	100%	110	110
2	1	NB	Y			08	00	WN	WN	73G	137							D	BNA	08	30	WN	WN	73G	137	90%	98%	123	120
3	1	NB		D	SEA	09	25	WN	WN	73G	137	77%	98%	106	104			D	PHL	09	55	WN	WN	73G	137	77%	95%	105	100
4	1	NB		D	LAS	10	10	WN	WN	73G	137	90%	96%	123	119			D	ABQ	10	35	WN	WN	73G	137	69%	96%	94	91
5	1	NB		D	AUS	11	45	WN	WN	73G	137	77%	97%	106	103			D	OAK	12	10	WN	WN	73G	137	67%	97%	92	89
6	1	NB		D	MDW	12	25	WN	WN	73G	137	72%	96%	99	95			D	PHX	13	00	WN	WN	73G	137	70%	96%	96	92
7	1	NB		D	SJC	13	15	WN	WN	73G	137	67%	97%	92	90			D	LAS	13	45	WN	WN	73G	137	75%	97%	103	100
8	1	NB		D	ABQ	14	05	WN	WN	73G	137	72%	96%	99	95			D	PVD	14	30	WN	WN	73G	137	64%	97%	87	85
9	1	NB		D	PHX	15	35	WN	WN	73G	137	70%	96%	96	93			D	SAT	16	00	WN	WN	73G	137	77%	96%	106	101
10	1	NB		D	MCI	16	25	WN	WN	73G	137	63%	98%	87	85			D	BNA	17	00	WN	WN	73G	137	90%	98%	123	120
11	1	NB		D	ABQ	18	50	WN	WN	73G	137	72%	96%	99	95			D	SEA	19	15	WN	WN	73G	137	77%	97%	105	102
12	1	NB		D	PHX	19	35	WN	WN	73G	137	70%	96%	96	93			D	PHX	20	05	WN	WN	73G	137	70%	96%	96	92
13	1	NB		D	RNO	22	45	WN	WN	735	122	70%	100%	86	86					00	00	WN	WN	735	122				
14	2	NB				00	00	WN	WN	73G	137							D	PHX	06	30	WN	WN	73G	137	77%	100%	105	105
15	2	NB		D	LAS	07	45	WN	WN	735	122	73%	96%	89	86			D	LAS	08	10	WN	WN	735	122	90%	97%	110	107
16	2	NB		D	SJC	09	50	WN	WN	73G	137	77%	97%	106	103			D	PHX	10	15	WN	WN	73G	137	70%	96%	96	92
17	2	NB		D	LAS	11	20	WN	WN	73G	137	77%	96%	106	102			D	SJC	11	45	WN	WN	73G	137	75%	96%	103	99
18	2	NB		D	OMA	12	00	WN	WN	73G	137	77%	97%	106	103			D	PHX	12	25	WN	WN	73G	137	70%	96%	96	92
19	2	NB		D	LAS	12	40	WN	WN	73G	137	73%	96%	100	97			D	MDW	13	15	WN	WN	73G	137	74%	97%	101	98
20	2	NB		D	PHX	16	25	WN	WN	73G	137	70%	96%	96	93			D	HOU	16	50	WN	WN	73G	137	77%	97%	105	102
21	2	NB		D	BNA	17	05	WN	WN	73G	137	50%	96%	69	66			D	MDW	17	30	WN	WN	73G	137	90%	97%	123	120
22	2	NB		D	MDW	18	05	WN	WN	73G	137	72%	96%	99	95			D	OAK	18	40	WN	WN	73G	137	90%	97%	123	120
23	2	NB		D	OAK	19	55	WN	WN	73G	137	90%	96%	123	119			D	SMF	20	20	WN	WN	73G	137	68%	96%	93	90
24	2	NB		D	PHX	21	15	WN	WN	735	122	77%	100%	94	94			D	RNO	21	40	WN	WN	735	122	70%	98%	85	84
25	2	NB		D	PHX	22	25	WN	WN	73G	137	70%	100%	96	96					00	00	WN	WN	73G	137				
26	3	NB				00	00	WN	WN	73G	137							D	SJC	07	45	WN	WN	73G	137	90%	100%	123	123
27	3	NB		D	MDW	08	22	WN	WN	73G	137	72%	96%	99	95			D	PVD	08	50	WN	WN	73G	137	90%	97%	123	120
28	3	NB		D	BWI	09	55	WN	WN	73G	137	72%	97%	99	96			D	BWI	10	25	WN	WN	73G	137	71%	97%	97	94
29	3	NB		D	PHL	10	45	WN	WN	73G	137	90%	97%	123	119			D	TUS	12	35	WN	WN	73G	137	63%	98%	86	84
30	3	NB		D	OAK	12	50	WN	WN	73G	137	72%	96%	99	95			D	ABQ	13	20	WN	WN	73G	137	69%	96%	94	91
31	3	NB		D	LAS	13	55	WN	WN	73G	137	73%	96%	100	97			D	SJC	14	25	WN	WN	73G	137	75%	96%	103	99
32	3	NB		D	SMF	14	50	WN	WN	73G	137	70%	96%	96	93			D	SMF	15	15	WN	WN	73G	137	68%	96%	93	90
33	3	NB		D	BWI	16	55	WN	WN	73G	137	72%	97%	99	96			D	BWI	17	25	WN	WN	73G	137	90%	97%	123	119
34	3	NB		D	SMF	18	35	WN	WN	73G	137	77%	96%	106	102			D	ABQ	19	05	WN	WN	73G	137	77%	96%	105	101
35	3	NB		D	SMF	19	25	WN	WN	73G	137	90%	96%	123	119			D	TUS	19	50	WN	WN	73G	137	77%	98%	106	103
36	3	NB		D	SEA	20	05	WN	WN	73G	137	77%	98%	106	104			D	OAK	20	35	WN	WN	73G	137	67%	97%	92	89
37	3	NB		D	HOU	20	54	WN	WN	73G	137	70%	98%	96	94		Y			21	24	WN	WN	73G	137				
38	3	NB		D	BWI	21	40	WN	WN	73G	137	72%	100%	99	99					00	00	WN	WN	73G	137				
39	4	NB				00	00	WN	WN	73G	137							D	MCI	07	20	WN	WN	73G	137	77%	100%	105	105
40	4	NB		D	OAK	07	55	WN	WN	73G	137	72%	96%	99	95			D	OAK	08	20	WN	WN	73G	137	90%	97%	123	120
41	4	NB		D	ABQ	09	15	WN	WN	73G	137	90%	96%	123	119			D	LAS	09	40	WN	WN	73G	137	77%	97%	105	102
42	4	NB		D	SJC	10	45	WN	WN	73G	137	67%	97%	92	90			D	PHX	11	15	WN	WN	73G	137	70%	96%	96	92

Exhibit 6.3. General approach to future design day gated flight schedule.



implicitly assumes there will be no peak spreading. A more intensive alternative to flight duplication is to examine schedules on an individual market basis and to add new flights based on gaps in the existing schedule.

In general, the preparation of design day schedules is a complex and time-consuming process which in most cases is best left to specialized consultants. Exhibit 6.3 provides a summary of the general approach but does not show all the detail required to complete a design day schedule. There are three major components to the process of preparing a design day schedule:

- Estimating and allocating market share;
- Estimating aircraft operations; and
- Assignment of passengers to flights.

6.2.1 Estimating and Allocating Market Share

The first step (Step 1 in Exhibit 6.3) is selecting a design day forecast of passengers or aircraft operations (see Chapter 4). The next step (Step 2 in Exhibit 6.3) is to distribute future design day activity among markets. This is important because O&D markets are a major determinant of aircraft type and passenger characteristics. Passengers can be allocated among markets using one of the methodologies 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; or
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.

Once design day passenger traffic is allocated by market, the seat capacity needed to serve each market can be calculated. The fleet mix most likely to account for daily seat departures to each market can then be estimated. This is a matter of judgment but should include the following considerations:

- Existing service patterns to the market;
- Current airline route strategies;
- Degree of competition in market;
- Known planned aircraft orders and retirements for each airline; and
- 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.

6.2.2 Design Day Schedule of Aircraft Operations

Once the market forecast is complete, the future flight schedule can be prepared (Step 3 in Exhibit 6.3). This typically involves starting with an existing schedule and then adjusting the schedule to match the fleet mix prepared in Step 2. For each market, this requires estimating times for new flights taking into account existing flight times to the market, the time zone of the market, and the service characteristics of the airlines serving or expected to serve that market. In many instances, aircraft equipment must be changed to match the fleet mix identified in Step 2. Finally, arriving flights must be matched to departing flights while ensuring enough time at the gate to load and unload passengers.

For most airfield simulation requirements and for terminal planning, aircrafts must be assigned to gates (Step 4 in Exhibit 6.3). Gate assignments typically consider buffer times between a departing flight and the next arriving flight at the gate, requirements for spare gates, and the types of aircraft the gate can accommodate. In addition, the distribution of aircraft among gates must be balanced to match real world use.

6.2.3 Assignment of Passengers to Design Day Schedule

If the design day schedule is to be used for terminal or landside analysis, passengers must be estimated for each flight (Step 5 in Exhibit 6.3). This involves applying load factors, which can vary by airline, market, and time-of-day, to each flight to generate passenger enplanements and deplanements. Next, an O&D percentage (proportion of passengers accounted for by originating or terminating passengers) must be assigned to each flight. This percentage will also vary by airline, market, and time-of-day.

Once these steps are complete, the result is a passenger-populated design day gated flight schedule ready for use in terminal or landside planning. 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 steps involved in preparing a design day schedule are covered in more detail in Chapter 6 of *ACRP WOD 14*.

6.3 Comments and Cautions

The following provides a list of items to be cautious of when preparing, reviewing or using design day schedules:

- The estimate of design day schedules is a detailed and time-consuming process, so errors are possible. Exhibit 6.4 provides a quality control checklist that can be used to help check design day schedules.
- Since most design day schedules are prepared to perform an airport analysis, there is a tendency to optimize the schedule for the airport—that is to schedule flight times to best serve the market. However, in reality it is airlines rather than airports that determine schedules. Although airlines have a definite financial interest in serving airports when passengers want to fly, they also need to optimize the use of their aircraft and must strike a balance. The existing distribution of operations at an airport, or similar airports, reflect this balance and can serve as a guide.
- Although the existing schedule is useful as a general guide to future distributions, it is simplistic to view a future schedule as a superimposition of new flights onto the existing schedule. Oftentimes, when adding a new flight to an existing market, airlines will rearrange the times of existing flights to provide better schedule coverage. See the *ACRP WOD 14* (Appendix Q).
- Gate 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 parsimonious with 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.
- The distribution of local traffic at airline connecting hubs will differ from the distribution of total passenger traffic. Data on the hourly distribution of local/connecting percentages is very scarce and would need to be obtained from the airlines. In most cases, airlines are unwilling or unable to provide this data in a timely manner. Judgment will be required to convert passenger profiles to O&D profiles and will need to consider the factors below:
  - It is useful to segregate passengers by carrier. Most connecting passengers will fly on aircraft flown by the hub carrier and its code-sharing and alliance partners. Traffic on airlines that do not have a hub operation will be almost 100 percent local.
  - 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

Exhibit 6.4. 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.

- [ ] **Arrivals/Departures Match Check:**

  Does the number of aircraft arrivals match the number of aircraft departures by airline and by equipment type for each airline? *An exception may be made if the purpose is to model a specific day of the week rather than a more general design day.*

- [ ] **Pairing Match Check:**

  At a gate, do all aircraft remain the same equipment type between arrival and departure? *This is obvious but sometimes overlooked.*

- [ ] **Gate Overlap Check:**

  Are all gates occupied by only ONE aircraft at all times?

- [ ] **Passenger Match Check:**

  Does the sum of passengers in the design day schedule match the design day estimate?

- [ ] **Turnaround Time Check:**

  Is there a sufficient interval for loading and unloading passengers and cargo, as well as 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 25 to 35 minutes whereas most mainline operators require 50 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 Check:**

  Has buffer time been provided between the scheduled departure time and the next arriving flight? *15 minutes is usually the minimum practical buffer time, although many airlines use 20-30 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 Time Check:**

  Do new flight times abide by all compatible airport curfews, and do arriving times at destination airports and departing times at origin airports correspond to when passengers are willing to fly and 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 2-3 PM, since such a flight would have to depart prior to 6 AM local time. Likewise, there is a dearth of departures for the East Coast at West Coast airports between 4 PM and 11 PM (Flights between these times would arrive past midnight but not late enough to be a reasonable "red eye" flight arriving early in the morning).*

- [ ] **Schedule Coverage Check:**

  Are scheduled flights realistic with origin/destination times, with as much coverage as possible through the day and with focus on the morning and afternoon peaks?

- [ ] **Consistency with Connecting Banks Check:**

  Are new flight times for carriers with hub-and-spoke networks 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.*

traffic. Likewise, flights that arrive after the last departing bank will have virtually no connecting traffic.

– Flights to and from small short-haul markets will have higher connecting ratios (lower O&D ratios) than flights to larger and longer-haul markets. Therefore, regional carrier feeder operations tend to have higher connecting ratios than mainline operations.
– If the resources are available, consider breaking out local/connecting splits by market. The U.S.DOT's O&D survey provides O&D by market and airline. This information, coupled with segment passenger data from the T-100 data base, allows individual airline and market O&D/connecting ratios to be generated.

CHAPTER 7

Preparation of Day/Night and Stage Length Profiles for Noise Analysis

This chapter provides techniques for estimating existing and future day/night splits and stage length profiles for use in the INM or the forthcoming AEDT. Also included is a discussion of the factors that may cause the balance between day and night operations to change, along with guidance on avoiding common pitfalls.

Estimates of existing and future day/night splits of aircraft operations by equipment type are required for noise analysis using the INM (see Chapter 6 for noise analysis using the NIRS model). These analyses require the division of aircraft operations into daytime flights (7 AM to 10 PM) and nighttime flights (10 PM to 7 AM). In California, an evening segment (7 PM to 10 PM) is also required. Noise impacts are a function of aircraft type and the payload they carry. Although load factors will vary, the required fuel load will be dependent on the length of the flight. When fuel loads are high, the aircraft is heavier, and it can gain altitude less quickly. To compensate, the aircraft must run on higher power to meet climb requirements, and therefore generates more noise. Consequently, estimates of aircraft stage length that organize aircraft departures into increments of 500 nautical miles are required.

This chapter first presents guidance on how to compile data on existing activity into a format suitable for the INM model. Next, guidance on preparing forecast day/night and stage length profiles is presented, followed by general comments and cautions.

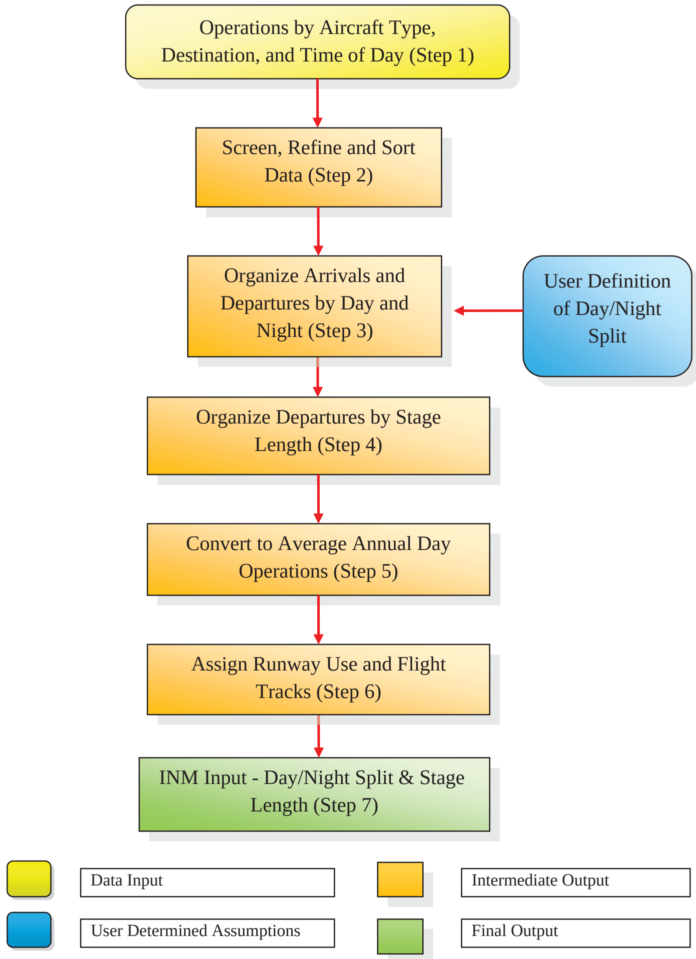
7.1 INM Input for Existing Conditions

Exhibit 7.1 shows an approach for estimating an existing day/night fleet mix and involves the following steps:

1. Collect existing annual aircraft operations data by aircraft type and time of flight, and also by destination for aircraft departures. Appendix B provides a list of data sources. Generally the best source of data, if available, is Air Traffic Control Tower (ATCT) radar collected on behalf of the airport, since this data covers all operations including general aviation (GA) and provides actual time of arrival and departure rather than scheduled time. USDOT T-100 data can provide information on fleet mix and stage length for commercial passenger and cargo carriers, but cannot provide time of day information. Since noise studies are intended to be representative of the entire year, data should be collected for an entire consecutive 12 month period if possible.

   The OAG can provide scheduled passenger operations data by airline, aircraft type, time of day, and stage length, but should be used with caution. The times reflect gate times rather than runway times, and do not account for delay. This data source therefore tends to underestimate the nighttime percentage of passenger operations. See Appendix I in the *ACRP WOD 14* for additional discussion.

Exhibit 7.1. Preparation of INM input for existing conditions.



In most cases some manipulation will be required to convert the data into the proper format for noise analysis, specifically:

a. Eliminate or correct typographic errors in the radar data. In some instances the intended aircraft type is clear; in those instances where the aircraft type is not clear it should be reclassified as an unknown.
b. Scale up identified flights to match annual totals. You will need to do this to offset missing information or information in which the aircraft type is identified as "unknown." This is best done separately by category (passenger carrier, cargo, GA, etc.) because some categories, such as military, tend to account for a disproportionate number of "unknown" flights.
c. Identify the airline for commercial carriers. This is important because often airlines may fly the same aircraft type, but still differ in the type of engine used, which in turn differ in noise characteristics. The engine-use information is not available from OAG, T-100, or radar data.
d. In some cases, such as general aviation operations operating under Visual flight rules (VFR), no operations data will be available. Estimates can be obtained from knowledgeable on-airport individuals such as fixed base operators (FBO). Based aircraft information can be used as a proxy if no other data on GA is available. However, it should be done with caution since the mix of transient operations does not always match the mix of based aircraft operations.

2. Designate flights as day or night based on the time of day information and the required definition of day and night, or evening if applicable.

Example 7.1. Scaling aircraft operations.

The total number of GA operations for which the aircraft type can be identified from the radar data is 46,000.

The known total of GA operations is 51,000. The ratio of the two numbers is (51,000/46,000) or 1.1087.

Multiply the operations for each identified aircraft type by 1.1087.

The sum of the results will equal 51,000.

3. Categorize flights by stage length based on the distance to destinations. The stage length categories used by INM are as follows:
   a. 0 to 500 nautical miles
   b. 501 to 1000 nautical miles
   c. 1001 to 1500 nautical miles
   d. 1501 to 2500 nautical miles
   e. 2501 to 3500 nautical miles
   f. 3501 to 4500 nautical miles
   g. 4501 to 5500 nautical miles
   h. 5501 to 6500 nautical miles
   i. 6501 and more nautical miles
4. Convert annual operations into AAD operations by dividing by the number of days in the year analyzed.
5. Assign flight tracks and runway use based on radar data and/or discussion with ATCT.
6. Code the operations for use in the INM or upcoming AEDT model. The INM model has specific categories of aircraft that do not always correspond to the categories in the radar data. In addition, some very new aircraft types are not modeled in the INM. In those instances, substitutes must be identified and approved by the FAA.

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, which should help to determine priorities in preparing these assumptions.

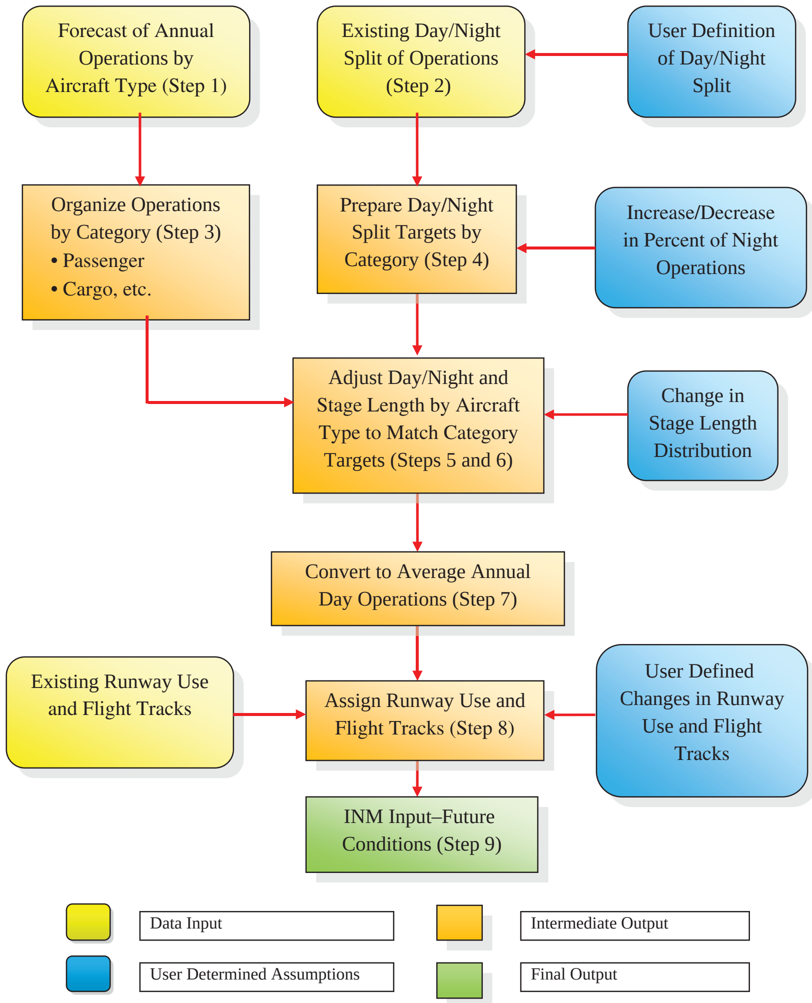
7.2 Future INM Fleet Mix

INM inputs representing future conditions require a fleet mix forecast. A fleet mix forecast is best prepared as part of the annual forecast, since the fleet mix will determine average aircraft size (measured in seats per aircraft). Average aircraft size, along with average load factor, determines passengers per passenger aircraft operation, and that in turn allows a forecast of passenger aircraft operations to be derived from a forecast of passenger enplanements. Ideally, therefore, the fleet and aircraft operations forecast will be prepared at the same time to ensure consistency.

Fleet mix forecasts require some judgment on the part of the practitioner. Important considerations include:

- Aircraft orders by the carriers serving the airport.
- Announced plans on aircraft retirements.
- Anticipated new markets, including size and distance.

Exhibit 7.2. Preparation of INM input for future conditions.



- Airfield capabilities, i.e., runway length.
- Level of competition—highly competitive markets tend to generate more frequencies with smaller aircraft than similarly sized non-competitive markets.

Exhibit 7.2 shows an approach for estimating the INM future day/night fleet mix at an airport which involves the following steps:

1. Select an annual fleet mix forecast and choose the year of analysis.
2. Obtain existing day/night stage length profile. If none are available, use the approach in Exhibit 7.1 to prepare an existing profile.
3. Organize the forecast of operations by category (passenger, cargo, GA, etc.).
4. Determine whether a change in the overall day/night split in each category is warranted. See Appendix I in *ACRP WOD 14* for additional guidance.
5. Estimate the future day/night split for each aircraft type in each category. Typically this is done by assuming the same day/night split that currently applies to that aircraft type. This may cause a distortion in the overall distribution, however. When a new aircraft type replaces an existing aircraft type, it will take over the existing aircraft's mission and therefore acquire its day/night distribution characteristics. Some adjustment may therefore be required to ensure that the aggregate nighttime percentage for the category is achieved. Example 7.2 is an illustration of this.

Example 7.2. Adjusting nighttime fleet mix to match control total.

Assume a simple case with three aircraft types showing the base year fleet mix below:

Annual Departures - Existing				
	Day	Night	Total	Night (%)
Boeing 737-800	27,000	3,000	30,000	10.0
Boeing 737-700	45,000	5,000	50,000	10.0
MD-80	40,000	10,000	50,000	20.0
Total	112,000	18,000	130,000	13.8

Assume an annual forecast that provides the fleet mix projections in green. If the base year nighttime percentages are applied to each aircraft type, the total nighttime percentage would fall from 13.8 percent to 11.3 percent. This is because the aircraft types that are growing (Boeing 737-700 and 737-800) have lower than average nighttime percentages in this case.

Annual Departures - Forecast Without Adjustment				
	Day	Night	Total	Night (%)
Boeing 737-800	45,000	5,000	50,000	10.0
Boeing 737-700	72,000	8,000	80,000	10.0
MD-80	16,000	4,000	20,000	20.0
Total	133,000	17,000	150,000	11.3

To adjust for this, calculate the ratio of the new unadjusted nighttime percentage (11.3 percent) to the base year nighttime percentage (13.8 percent).

	Ratio of Future Unadjusted to Existing Night %			
13.8%	divided by	11.3%	=	1.22

Multiply the nighttime percentage for each aircraft type by the ratio (1.22) to generate adjusted nighttime percentages (in orange) for each aircraft type. Calculate adjusted nighttime departures (in blue) by multiplying total departures by the adjusted nighttime percentage. Daytime departures are equal to total departures less nighttime departures.

Annual Departures - Forecast With Adjustment				
	Day	Night	Total	Night (%)
Boeing 737-800	43,891	6,109	50,000	12.2
Boeing 737-700	70,226	9,774	80,000	12.2
MD-80	15,113	4,887	20,000	24.4
Total	129,231	20,769	150,000	13.8

Note that the adjusted total forecast nighttime percentage (13.8 percent) is now the same as the base year nighttime percentage.

6. Estimate the future stage length for each aircraft type in each category. It may not be safe to assume that the future stage length distribution for an aircraft type will be the same as the existing distribution. Airlines often dedicate their newer aircraft to long-haul routes and older aircraft to short-haul routes since the fuel economies associated with new aircraft are better realized on longer routes. However, as these new aircraft take over routes from existing aircraft they will gradually assume some of their stage length characteristics as well. Therefore, some adjustment may be necessary to ensure that the aggregate stage length distributions for the category are achieved.
7. Divide the results from Steps 5 and 6 by the number of days in the year to produce a future AAD day/night fleet mix.
8. Assign future runway use and flight tracks. Incorporate any anticipated changes in air traffic control practices and airspace structure. Typically information on Standard Terminal Arrival Routes (STARs) and Standard Instrument Departure (SID) routes, along with radar data such as NOMS or PDARS, is used to generate model input for existing flight tracks and runway use distributions. These distributions can be modified to represent future conditions by using output from airfield/airspace simulation models or input from ATCT staff.
9. Code the operations for use in the INM or upcoming AEDT model.

7.3 Comments and Cautions

Consider the following when preparing a future day/night fleet mix:

- In general, long-haul travel has been growing faster than short-haul travel, and this may affect the overall stage length distributions. This is likely to be especially important at constrained airports, where airlines are more likely to preserve the more financially remunerative long-haul flights at the expense of short-haul flights. In addition, potential future competing transportation modes, such as high-speed rail, are more likely to compete with short-haul and medium-haul air travel than with long-haul travel.
- International passenger flights warrant special attention. Historically, most overseas flights from U.S. airports have been to Europe and Japan. These flights tend to operate almost exclusively during the day due to the time zones and connecting banks at these airports. However, these daytime distributions do not necessarily apply to some of the newer overseas markets. For example, most flights to southern South America are red-eye flights which often land and take-off during the night at U.S. airports. Flights to South Asia (India and surrounding countries) and Oceania (Australia/New Zealand) also often land and take-off at night (see Appendix N in ACRP 03-12 Final Report). Therefore, it is essential to pay special attention to shifts in international service. For obvious reasons, these shifts will also affect stage length distributions.

CHAPTER 8

Preparation of Peak Period Forecasts

This chapter discusses how to use the Toolbox to estimate peak period activity levels from design day profiles based on user-specified criteria. The chapter includes sample problems and provides some comments and cautions on how to calculate and use the results.

The desired peak period will differ depending on the needs of the user and the facility being analyzed. Once defined, however, the process for estimating peak periods is similar regardless of the definition or threshold. Two sets of approaches are presented here depending on how the peak period is defined. The first, and simplest, approach assumes the peak period is defined as the busiest period in the design day. The second approach assumes a peak period definition that is independent of the design day. For example, if the peak period is defined as 60 minutes and represents a level that equals or exceeds activity in all but five percent of the year, the preparer would select the 438th busiest hour of the year (5 percent multiplied by 8,760 hours). The Toolbox uses the first approach for calculating peak period activity levels.

8.1 Peak Period Operations

8.1.1 Estimates of Existing Peak Period Operations

Exhibit 8.1 provides an outline of the steps used to estimate existing peak period operations based on the design day.

Required inputs are design day operations (see Chapter 4), detailed operations data for a representative day (including arrival and departure times) and a user definition of the peak period (15 minutes, 30 minutes, etc.). Potential sources for the representative data input day include aircraft monitoring data, if collected by the Airport, or ETMS data from the FAA. See Appendix B for more information on data sources.

The Toolbox calculates activity levels based on a rolling average, so that peak periods that do not correspond to clock hour intervals are still identified. Once the rolling averages are calculated the peak corresponding to the user determined peak period interval is calculated. If estimates for several alternative definitions of the peak period are required, the process can be repeated using the alternative definition.

8.1.2 Estimates of Future Peak Period Operations

Exhibit 8.2 describes two approaches for estimating future peak period operations. The first approach is simpler and can be applied if a peak spreading factor is not used and no major changes in the distribution of operations throughout the day are anticipated.

Exhibit 8.1. Process for estimating existing peak period aircraft operations.

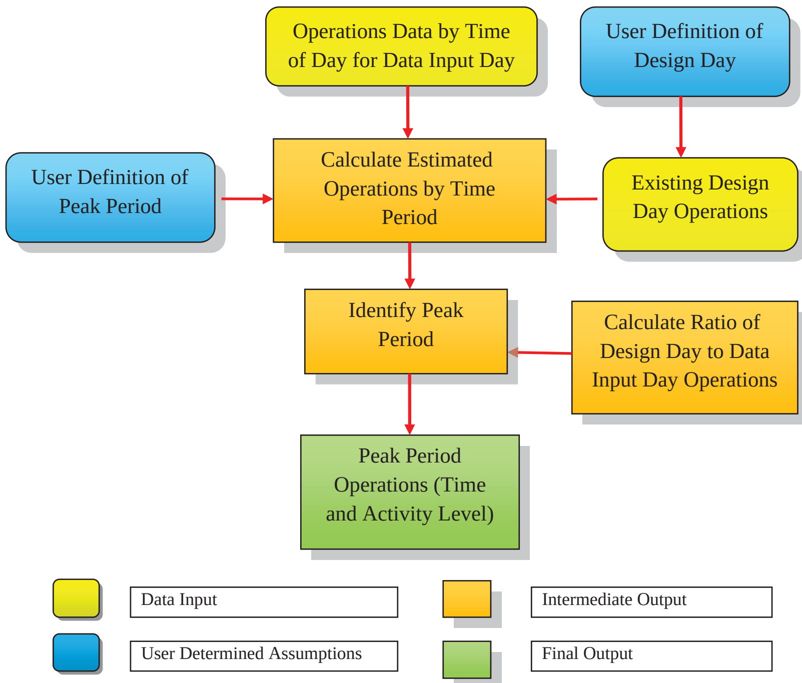
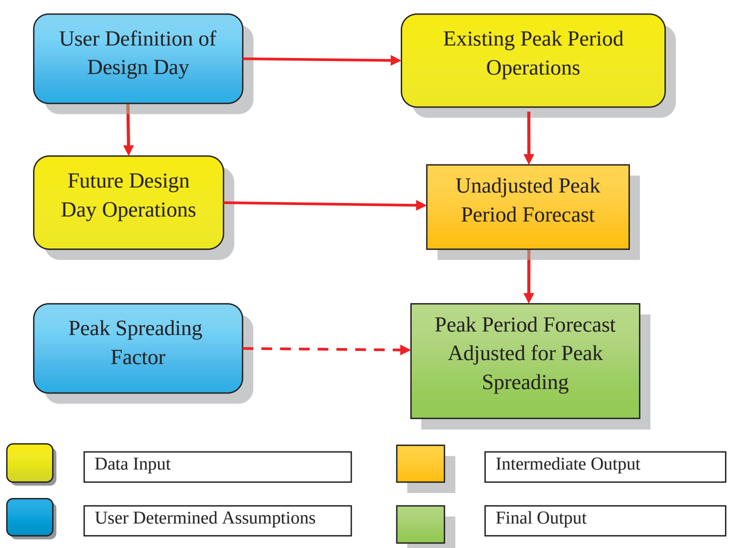


Exhibit 8.2. Process for estimating forecast peak period aircraft operations.



The Toolbox methodology assumes that, without peak spreading, peak period operations will grow at the same rate as annual operations. It also provides an alternate calculation that assumes an average degree of peak spreading as the forecasted annual operations increase. See Appendix H in the *ACRP WOD 14* for additional detail.

8.1.3 Use of Toolbox

Peak period operations can be quickly calculated using the operations module of the Toolbox. The following sample problem shows how to use the Toolbox to estimate future peak period operations.

Sample Problem 8.1

Problem Statement: Determine whether hourly runway arrival capacity will be exceeded within 15 years.

Airport: Large Commercial Airport in Mountain Time Zone

Forecast Element: Peak Period Aircraft Arrivals

Toolbox Module: Operations

An airport planner has been asked to project when his airport will exceed its runway capacity. The planner knows that under Instrument Flight Rules (IFR) conditions the design airport has an arrival capacity of 140 aircraft arrivals per hour and also knows that arrivals are more likely to be a chokepoint than departures.

As shown in the screenshot of the *B. User Parameters* input worksheet in Exhibit 8.3, the planner provides a forecast of annual operations for 2020 (A). The model will be run later with 2025 forecast data. The planner specifies an output of arriving operations (B). The planner is also interested in a range of peak period thresholds, and includes two percent, five percent, and 10 percent design day definitions (C). The planner next chooses to analyze hourly capacity (D) and designates that the peak period time interval will be identified by the time in which it begins (E).

Next arrival and departure operations data by time of day for a representative day and arriving and departing operations by day of the year for the base year are entered in the *C. Base Year* data input worksheet (Exhibit 8.4).

The planner anticipates some peak spreading, so looks to the H. Peak Period—Spread worksheet for answers (Exhibit 8.5).

The planner finds that even at the two percent threshold, the demand will be 133 aircraft arrivals, still below the 140 operation estimated capacity. Next the model is run for 2025 activity levels, by typing in 2025 forecast operations in the User Parameter worksheet. No other changes to the inputs are required.

The planner finds that, under the 2025 forecast (Exhibit 8.6), the runway capacity of 140 arrivals is exceeded at all the defined thresholds including the one represented by the average day peak month.

At this point, the planner could easily estimate the year in which runway capacity is exceeded by interpolating between the two sets of results, but decides that it would be easier and more accurate by running the Toolbox again with annual forecast values for 2021 through 2024.

Exhibit 8.3. User parameter input worksheet.

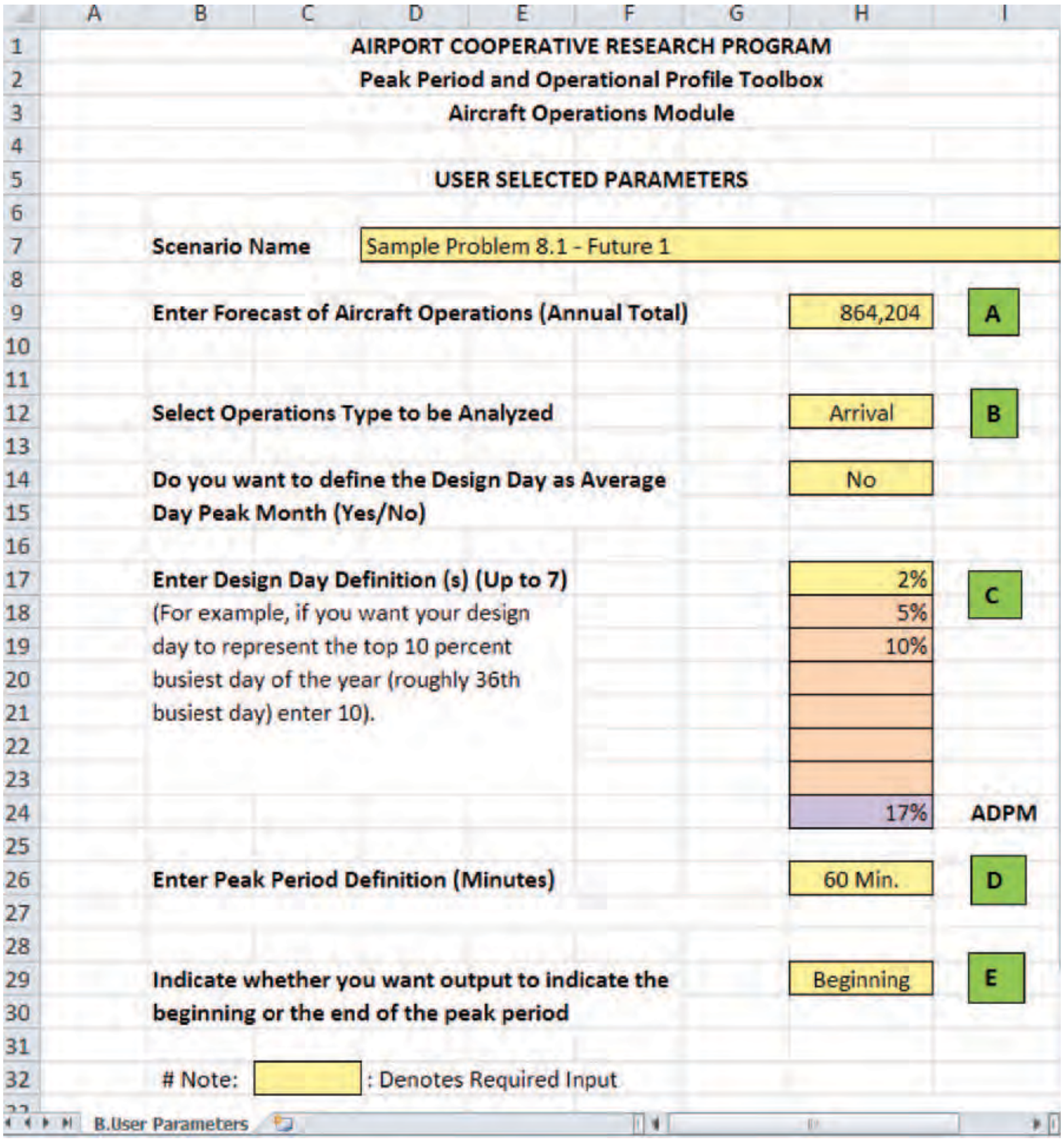


Exhibit 8.4. Base year data input worksheet.

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
10	12:12 AM	D	C	B737	1/1/2009	786	789	1575
11	12:24 AM	A	C	B737	1/2/2009	886	888	1774
12	12:24 AM	D	C	A320	1/3/2009	802	803	1605
13	12:40 AM	D	C	B752	1/4/2009	841	845	1686
14	12:37 AM	D	T	E120	1/5/2009	862	864	1726
15	12:44 AM	D	C	A319	1/6/2009	852	855	1707
16	12:47 AM	D	C	A320	1/7/2009	841	841	1682
17	1:23 AM	D	C	A319	1/8/2009	852	853	1705
18	1:26 AM	D	C	B752	1/9/2009	849	850	1699
19	2:59 AM	A	C	B752	1/10/2009	701	704	1405
20	3:36 AM	A	C	A306	1/11/2009	767	768	1535
21	3:44 AM	A	T	SW4	1/12/2009	802	805	1607
22	3:59 AM	A	C	A306	1/13/2009	838	840	1678
23	4:20 AM	A	C	A306	1/14/2009	827	840	1667
24	4:29 AM	A	C	MD11	1/15/2009	842	844	1686
25	4:23 AM	D	C	B752	1/16/2009	851	854	1705
26	4:46 AM	A	T	SW4	1/17/2009	702	704	1406
27	4:48 AM	A	C	DC10	1/18/2009	769	772	1541
28	5:07 AM	A	P	PA31	1/19/2009	832	834	1666
29	5:20 AM	D	C	A306	1/20/2009	834	838	1672
30	5:44 AM	A	C	A319	1/21/2009	845	847	1692
31	5:52 AM	A	C	DC87	1/22/2009	853	854	1707
32	5:55 AM	A	C	DC87	1/23/2009	841	843	1684
33	5:47 AM	D	C	B722	1/24/2009	711	714	1425
34	5:55 AM	D	C	A306	1/25/2009	736	737	1473
35	6:06 AM	D	C	A319	1/26/2009	808	810	1618
36	6:02 AM	D	T	SW4	1/27/2009	835	836	1671

C Base Year data

Exhibit 8.5. Peak period estimate worksheet: Future 1.

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

PEAK PERIOD ESTIMATES
(Assumes Peak Spreading)
Sample Problem 8.1 - Future 1

Base Year

Peak Period in Design Day

Arrivals

Selected top X % busiest day	Rank	Rolling 60 min
ADPM	62	92
2%	7	97
5%	18	96
10%	35	94

Arrivals

Peak Period definition	Clock Time*
Rolling 60 min	16:28

Forecast Year (w/ Peak Spreading)

Future Peak Period in Design Day

Arrivals

Selected top X % busiest day	Rank	Rolling 60 min
ADPM	62	126
2%	7	133
5%	18	131
10%	35	129

Arrivals

Peak Period definition	Clock Time*
Rolling 60 min	16:28

*** Note: Clock Time is when the given Peak Period Begins**

ADPM: Average Day in Peak Month

Base Year Annual Operations	611,888
Forecast Year Annual Operations	864,204
Design Day Definition	2%

H Peak Period - Spread

Exhibit 8.6. Peak period estimate worksheet: Future 2.

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

PEAK PERIOD ESTIMATES
(Assumes Peak Spreading)
Sample Problem 8.1 - Future 2

Base Year

Peak Period in Design Day

Arrivals

Selected top X % busiest day	Rank	Rolling 60 min
ADPM	62	92
2%	7	97
5%	18	96
10%	35	94

Arrivals

Peak Period definition	Clock Time*
Rolling 60 min	16:28

Forecast Year (w/ Peak Spreading)

Future Peak Period in Design Day

Arrivals

Selected top X % busiest day	Rank	Rolling 60 min
ADPM	62	141
2%	7	149
5%	18	147
10%	35	144

Arrivals

Peak Period definition	Clock Time*
Rolling 60 min	16:28

*** Note: Clock Time is when the given Peak Period Begins**

ADPM: Average Day in Peak Month

Base Year Annual Operations	611,888
Forecast Year Annual Operations	975,912
Design Day Definition	2%

H. Peak Period - Spread

8.2 Peak Period Passengers

8.2.1 Estimates of Existing Peak Period Passengers

The general approach to estimating existing peak period passengers is similar to the approach for estimating design day operations. Since hourly data on passenger levels is typically unavailable, additional steps are required for the estimate. Exhibit 8.7 shows an approach for estimating peak period passengers.

Required inputs are design day passengers (see Chapter 4), detailed scheduled seat arrival and departure data for a representative day (including arrival and departure times) and a user definition of the peak period (15 minutes, 30 minutes, etc.). The best source for the representative of scheduled seat information for the data input day is the OAG. See Appendix B for more information on data sources.

The Toolbox calculates passenger activity levels based on a rolling average, so that peak periods that do not correspond to clock hour intervals are still identified. Once the rolling averages are calculated the peak corresponding to the user determined peak period interval is calculated. If estimates for several alternative definitions of the peak period are required, the process can be repeated using the alternative definitions. Peak period passengers can be converted into peak period originations by applying an origination to enplanement ratio.

Impacts of unusual situations, such as schedule disruptions from adverse weather, can be modeled by manually adjusting the schedule input in the Toolbox to reflect those conditions.

Exhibit 8.7. Process for estimating existing peak period passengers.

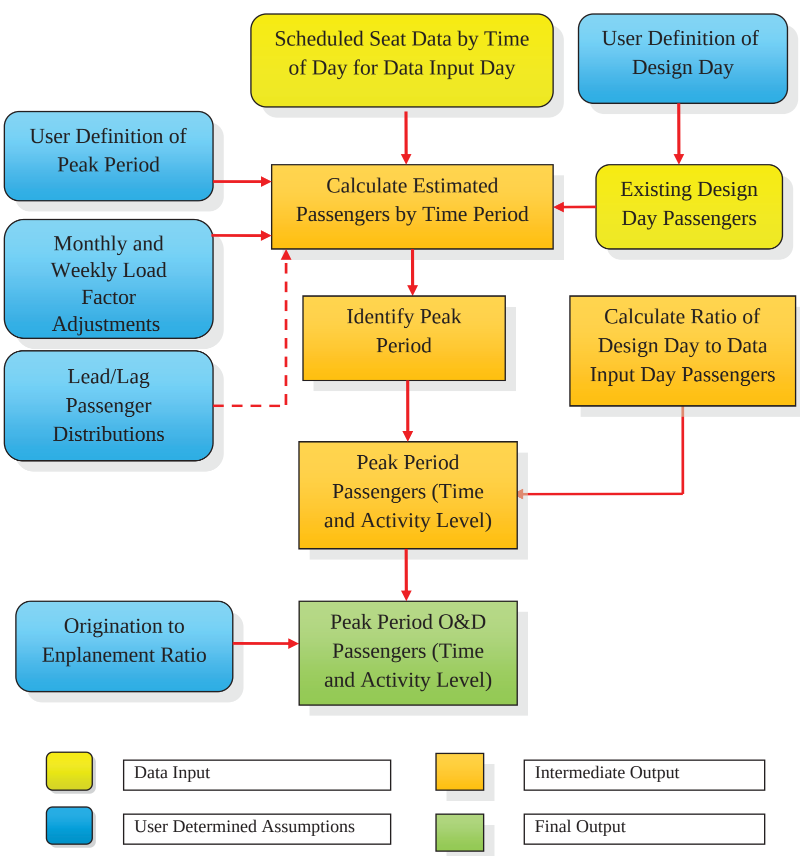
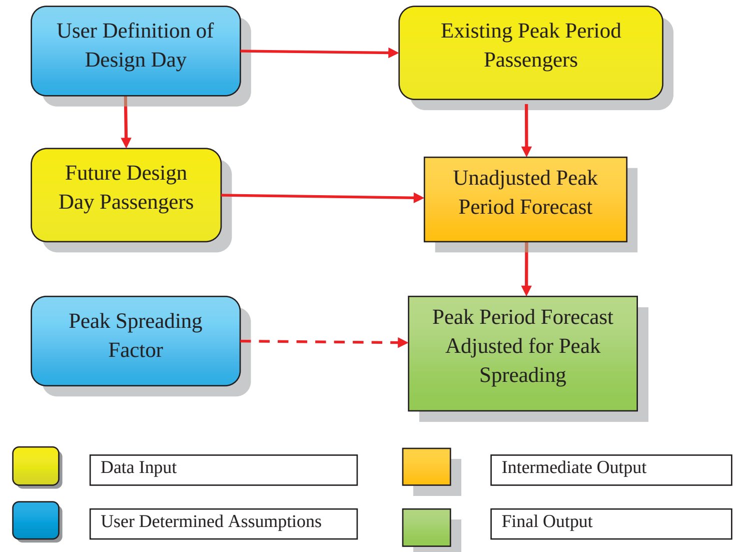


Exhibit 8.8. Process for estimating forecast peak period passengers.



8.2.2 Estimates of Future Peak Period Passengers

Exhibit 8.8 describes approaches for estimating future peak period passengers with and without peak spreading.

8.2.3 Use of Toolbox

Peak period passenger arrivals and departures can be calculated using the passenger module of the Toolbox. The following sample problem shows how to use the Toolbox to estimate future peak period passengers.

Sample Problem 8.2

Problem Statement: Estimate how many security lanes will be required in 15 years.

Airport: Large Commercial Airport in Pacific Time Zone

Forecast Element: Peak Period Passenger Originations

Toolbox Module: Passenger

In Sample Problem 8.2, an airport recently lost one of its main carriers leading to a significant change in its flight schedule and hourly distribution of operations and seat capacity. The terminal planner wants to know whether this will change the number of security lanes they are planning as part of a terminal building renovation and expansion. As shown in Exhibit 8.9, the planner enters the forecast passenger enplanements (A), specifies departing passengers (B), and types in the design day thresholds to be analyzed (C). In addition, the peak period is defined as 15 minutes (E), and the time of the peak to be defined by its end point (F) was identified.

In the bottom half of the *B. User Parameters* worksheet the planner adds monthly enplanement data (G) and load factor adjustments by day of the week (H) for her airport (Exhibit 8.10).

Exhibit 8.9. User selected parameters.

Peak Period and Operational Profile Toolbox
Passenger Module

USER SELECTED PARAMETERS (page 1)

Scenario Name:	Sample Problem 8.2	
Enter Forecast of Annual Passenger Enplanements (Annual Total)	13,272,526	A
Select Arrival/Departure Type to be Analyzed	Departures	B
Do you want to define the Design Day as Average Day Peak Month (Yes/No)	No	C
Type in Design Day Definition (s) (Up to 7)	10%	D
(For example, if you want your design day to	2%	
represent the top 10 percent busiest day of	5%	
the year (roughly 36th busiest day) enter 10).	15%	
	20%	
	25%	
	40%	
	12%	ADPM
Enter Peak Period Definition (Minutes)	15 Min.	E
Indicate whether you want output to indicate the beginning or the end of the peak period	End	F

Exhibit 8.10. User parameter: enplanements and load factor.

Enter Monthly Enplanements for Base Year (Each Month) — G

Monthly Enplanements		
Jan.	1	523,455
Feb.	2	507,521
Mar.	3	703,822
Apr.	4	683,407
May	5	745,325
Jun.	6	852,200
Jul.	7	867,072
Aug.	8	882,504
Sep.	9	651,854
Oct.	10	623,708
Nov.	11	675,204
Dec.	12	703,762
Total		8,419,834

Enter Day of Week Load Factor Adjustment Factor (Load Factor for Day)/(Average Load Factor for Week) — H

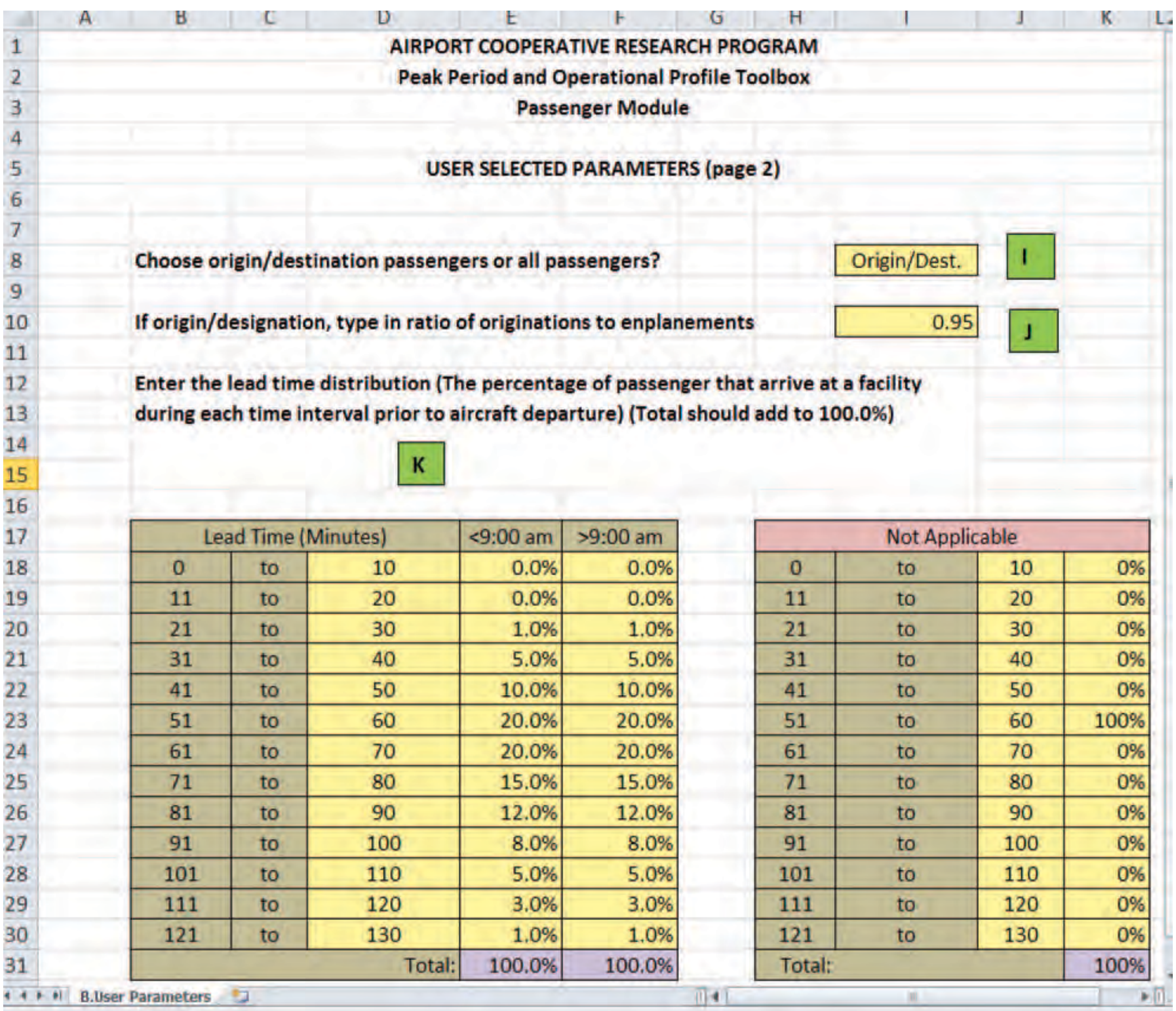
Day of Week Load Factor		
Sun	1	1.020
Mon	2	0.992
Tue	3	0.959
Wed	4	0.970
Thu	5	1.019
Fri	6	1.048
Sat	7	0.990

Since security requirements are primarily determined by originating passengers, the planner specifies originations to be analyzed (I), which account for 95 percent of enplanements (J) at the design airport (Exhibit 8.11). Finally, the latest available information showing the distribution of the times that a passenger reaches security (K) and the time their flight departs the gate are entered.

Next, the planner goes to the *C. Base Year Data* worksheet and types in existing annual enplanements, and scheduled seat arrivals and departures for a representative day, and the base year (Exhibit 8.12).

The terminal planner then goes to the *J. Peak Period—PS* worksheet to view the results (Exhibit 8.13). Results show that peak period originations would be 1665 or higher on 10 percent of the days and 1772 or higher on two percent of the days. Assuming that the TSA can process 60 passengers per security lane every 15 minutes, a need for 28 total security lanes is estimated. The planner also notes that the peak hour occurs around noon, whereas the 15-minute peak period occurs shortly after 6:00 AM. Had the planner estimated the peak period as a percentage

Exhibit 8.11.



AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

USER SELECTED PARAMETERS (page 2)

Choose origin/destination passengers or all passengers? Origin/Dest. I

If origin/designation, type in ratio of originations to enplanements 0.95 J

Enter the lead time distribution (The percentage of passenger that arrive at a facility during each time interval prior to aircraft departure) (Total should add to 100.0%)

K

Lead Time (Minutes)			<9:00 am	>9:00 am
0	to	10	0.0%	0.0%
11	to	20	0.0%	0.0%
21	to	30	1.0%	1.0%
31	to	40	5.0%	5.0%
41	to	50	10.0%	10.0%
51	to	60	20.0%	20.0%
61	to	70	20.0%	20.0%
71	to	80	15.0%	15.0%
81	to	90	12.0%	12.0%
91	to	100	8.0%	8.0%
101	to	110	5.0%	5.0%
111	to	120	3.0%	3.0%
121	to	130	1.0%	1.0%
		Total:	100.0%	100.0%

Not Applicable			
0	to	10	0%
11	to	20	0%
21	to	30	0%
31	to	40	0%
41	to	50	0%
51	to	60	100%
61	to	70	0%
71	to	80	0%
81	to	90	0%
91	to	100	0%
101	to	110	0%
111	to	120	0%
121	to	130	0%
Total:			100%

B.User Parameters

Exhibit 8.12. Base year data worksheet.

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
12:09 AM	172	A	P	739
12:22 AM	182	A	P	752
12:45 AM	258	A	P	A343
12:47 AM	144	A	P	734
12:50 AM	157	A	P	738
12:55 AM	160	A	P	73H
1:13 AM	155	A	P	738
2:44 AM	126	A	P	A319
2:52 AM	144	A	P	734
4:15 AM	144	A	P	734
4:54 AM	216	A	P	753
4:54 AM	172	A	P	739
5:31 AM	224	A	P	753
5:33 AM	140	A	P	MD80
5:44 AM	144	A	P	734
5:49 AM	224	A	P	753
6:05 AM	74	A	P	DH4
6:09 AM	172	A	P	739
6:20 AM	74	A	P	DH4

Base Year - Scheduled Seats by Day of the Year

MM/DD/YYYY	Arriving	Departing	Arriving + Departing
1/1/2009	29,231	29,180	58,411
1/2/2009	31,834	31,858	63,692
1/3/2009	29,239	29,226	58,465
1/4/2009	30,262	29,909	60,171
1/5/2009	31,234	31,040	62,274
1/6/2009	30,699	30,714	61,413
1/7/2009	30,521	30,670	61,191
1/8/2009	30,837	30,814	61,651
1/9/2009	30,910	31,116	62,026
1/10/2009	25,653	25,184	50,837
1/11/2009	28,565	28,677	57,242
1/12/2009	30,608	30,744	61,352
1/13/2009	30,222	30,245	60,467
1/14/2009	30,322	30,322	60,644
1/15/2009	30,555	30,555	61,110
1/16/2009	30,675	30,868	61,543
1/17/2009	24,094	23,670	47,764
1/18/2009	28,519	28,573	57,092
1/19/2009	30,555	30,732	61,287

C Base Year Data

Exhibit 8.13. Peak period estimates worksheet.

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Passenger Module

PEAK PERIOD ESTIMATES
(Assumes Peak Spreading)

Sample Problem 8.2
Departing Passenger Count - Origin-Destination Passengers

Base Year

Peak Period in Design Day

Selected top X % busiest day	Rank	Rolling 15 min
ADPM	44	1073
10%	36	1086
2%	7	1155
5%	18	1117
15%	54	1056
20%	73	1028
25%	91	968
40%	146	897

Peak Period definition	Clock Time*
Rolling 15 min	6:09

Forecast Year (w/ Peak Spreading)

Future Peak Period in Design Day

Selected top X % busiest day	Rank	Rolling 15 min
ADPM	44	1644
10%	36	1665
2%	7	1772
5%	18	1713
15%	54	1619
20%	73	1577
25%	91	1484
40%	146	1375

Peak Period definition	Clock Time*
Rolling 15 min	6:09

***Note: Listed clock time is when peak period Begins**

ADPM: Average Day in Peak Month

Base Year Annual Passenger Enplanements	8,419,834
Forecast Year Annual Passenger Enplanements	13,272,526
Design Day Definition	10%

1 Peak Period - PS

of the peak hour, there might have been an underestimate of the number of peak 15-minute originations.

8.3 Comments and Cautions

The Toolbox is not capable of analyzing all issues and problems, so the following comments and cautions should be considered.

- 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 changes in the relationship between mainline carriers and feeders, and airline consolidation. These factors could significantly reduce the Toolbox's ability to forecast future peak period activity from existing data at some airports.
- For some types of transportation planning the peak hour is defined independently of the design day. For example, in highway planning, the 30th busiest hour of the year is used, without reference to a design day. At airports, there is no assurance that, for example, the 30th busiest hour will occur during the 30th busiest day. An accurate calculation would require hourly activity data for the entire year. Although some airports have, or can acquire this data for operations, it is not available for passengers. Therefore, the Toolbox estimates peak period activity based on the design day.

CHAPTER 9

Application of Constraints

This chapter shows how physical or policy constraints may affect the magnitude of the peaks and the distribution of daily activity and provides guidance on how to model these aspects.

One of the more difficult aspects of estimating future peak period activity or operational profiles is how to best incorporate the impact of airport constraints. Addressing constraints in annual forecasts is beyond the scope of this guidebook, so the focus will be on how to evaluate the impact of constraints on a daily or less-than-daily basis. Even if an airport fully intends to expand to accommodate increased demand, constrained forecasts are often necessary to identify no-action (without project) operational conditions as a baseline which can be used to measure project benefits and environmental impacts. Constraints can be imposed by insufficient physical infrastructure or by policy restrictions.

Physical constraints can include:

- Airfield constraints such as the lack of runway, taxiway, and queuing capacity;
- Terminal constraints such as the lack of gate capacity, or chokepoints within the terminal building, such as security clearance, people mover systems, and baggage processing; and
- Landside constraints, such as limits on roadway, curbside, and automobile parking capacity.

Policy constraints can include:

- Slot controls;
- Peak period pricing (higher landing fees during busy times); and
- Nighttime noise restrictions or curfews.

These differing constraints will affect peak or operational activity in different ways.

9.1 Airfield Constraints

The hourly throughput capacity of an airfield needs to be estimated before the impact of airfield constraints can be analyzed. This is best done using an airfield simulation model such as SIMMOD or TAAM. The result will not be a single capacity number, but rather a relationship that can be graphed between aircraft arrival capacity and departure capacity. Increased arrival capacity will come at the expense of decreased departure capacity, and vice versa.

Chen and Gulding[x] authored a paper, "Assessment of System Constraints for Producing Constrained Feasible Schedules," that provides a means of estimating the impact of airfield throughput capacity on airline schedules. The authors identified the existing relationship between scheduled demand and existing visual meteorological conditions (VMC) capacity at John F.

Exhibit 9.1. Maximum demand/capacity ratio by peak period definition.

Peak Period Definition		Maximum Demand/Capacity Ratio (Aircraft Operations)
15 minutes		1.41
1 hour		1.21
2 hours		1.14
3 hours		1.06

Kennedy International (JFK) and Newark Liberty International (EWR) Airports. The authors noted from previous FAA work that although scheduled demand could exceed capacity for short periods of time, 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 (see Exhibit 9.1).

Assuming airport throughput capacity estimates are available, these ratios can be used to establish upper limits on the number of aircraft operations scheduled for each period. See Example 9.1 for a sample calculation. Multiplying the throughput capacity by the ratio will provide a control total for operations that will limit the extent of the peaks in constrained daily profiles and design day schedules.

If airfield capacity cannot accommodate unconstrained demand, airlines have several potential options for reducing flights:

- Reschedule flights to off-peak hours;
- Increase the size of the aircraft serving a market, while reducing frequency;
- Increase load factors so that more passengers can be flown with a given amount of seat capacity;
- At connecting airports, divert connecting passengers through other hubs or gateways in their network;
- Increase fares to reduce the number of O&D passengers to be accommodated; or
- Cease or reduce service to certain markets.

Example 9.1. Applying demand/capacity ratios.

Assumption: Departure Throughput Capacity = 80/hr

15 minute maximum departures = 80 dept/hr × (15 min/60min) × 1.41 = maximum of 28.2 scheduled departures in a 15 minute period.

1 hour maximum departures = 80 dept/hr × (60 min/60min) × 1.21 = maximum of 96.8 scheduled departures in a 1 hour period.

2 hour maximum departures = 80 dept/hr × (120 min/60min) × 1.14 = maximum of 182.4 scheduled departures in a 2 hour period.

3 hour maximum departures = 80 dept/hr × (180 min/60min) × 1.06 = maximum of 254.4 scheduled departures in a 3 hour period.

The airlines' ability to pursue the above options is limited by the following factors:

- Existing and planned aircraft fleet;
- Network requirements, especially the type of aircraft needed to serve all their markets—not just the airport under study;
- A competitive environment, which would affect both the ability to reduce frequency and to raise fares without losing passengers and revenue; and
- Market characteristics such as length of haul, which would affect passengers' ability to use alternative transportation modes.

Based on empirical analysis and surveys conducted at several airports,[xi] the airlines would take the following actions, ranked in order of likelihood:

- Increase fares to take advantage of reduced competition and to cover increased operating costs, thereby reducing the number of passengers from unconstrained levels;
- Reschedule some flights to less busy connecting banks or off-peak hours subject to market requirements;
- Increase the average size of the aircraft serving the market, provided the required aircraft are in their fleet.
- Cease or reduce service to certain markets, starting with the lowest revenue markets (typically short-haul and leisure markets).

Although it is counterintuitive, the evidence from these studies suggests that there will be little change in load factors.

Minimal analysis has been done on the impact of airfield constraints on operations besides those of scheduled passengers, but the following observations are pertinent:

- Passenger charter and all-cargo operations generally occur off-peak and would be unaffected. They also tend to have greater flexibility in adjusting schedules or using available supplemental airports if they have adequate runway length.
- General aviation operations by smaller aircraft (piston and turboprop) often avoid busy commercial airports even when there are no significant capacity constraints. They can typically be persuaded to use reliever airports.
- There is often a core of more sophisticated business jet operations that is difficult to dislodge. They are attracted to the all-weather instrument capability, access to air service, and often access to downtowns. Although they are often reluctant to change airports, they do have some flexibility to change flight times.

Because of their complexity, the above factors are best addressed by incorporating them into a constrained design day schedule. The design day schedule can then be used to prepare constrained daily profiles and peak period estimates as needed.

9.2 Terminal Constraints

The effects of terminal constraints will differ depending on whether the chokepoints are at the gates or at other terminal facilities. The impact of gate constraints on aircraft operations and passengers depends on the characteristics of the airlines serving the airport.

Gate utilization for hub carriers is limited by the number of connecting banks, and large hub operations such as Delta at Atlanta can sustain more connecting banks than small hub operations, such as Delta at Memphis. Note that average gate utilization is typically less than the number of connecting banks, for various reasons. Not all connecting banks are of equal size, and therefore some gates will be unoccupied during the smaller banks. Also, some aircrafts, especially in overseas international service, may sit at a gate for more than one connecting bank. And, as was mentioned in Chapter 6, there is a need for excess gate capacity (spare gates) to accommodate disrupted schedules.

Even at spoke airports, airlines with hub-and-spoke operations will be constrained by the timing of the connecting banks at the origin or destination airport. Airlines without formal hub-and-spoke networks, like Southwest Airlines, have more schedule flexibility and can achieve higher gate utilization rates.

ACRP WOD 14 (Appendix O) provides some examples of the relationship between peak period operations and the number of gates at selected airports where gates are used intensively. These relationships may be used as a general guide to the maximum design day departures possible when the number of gates is constrained. Airline reactions to terminal constraints will be similar to their reactions to airfield constraints with one exception. Except at slot-controlled airports, such as Washington's Reagan National Airport, airfield capacity is common-use, whereas gates are typically exclusive-use or preferential-use. Since individual airlines have more control over gate capacity than airfield capacity, they have more flexibility to "right-size" utilization to meet operational concerns without the risk of competing airlines backfilling the freed up capacity. Airlines therefore have more ability to exploit gate constraints to raise fares than they have with airfield constraints.

Non-gate terminal constraints modify passenger activity differently than gate constraints. Non-gate terminal constraints, such as security or people-mover systems, directly affect passengers and then indirectly affect the airlines. Gate constraints directly affect the airlines and then indirectly affect passengers. Since passengers will modify their behavior to accommodate potential chokepoints by increasing lead or lag times, airlines generally do not feel compelled to modify their schedules.

ACRP Report 25 contains several mini-queuing models that can be used to estimate the impact of constraints in ticketing, passenger screening, and Customs and Border Protection on passenger flow rates, in effect providing peak period constrained forecasts.

9.3 Landside Constraints

Landside constraints are similar to non-gate terminal constraints in that they directly affect the passenger and only indirectly affect the airlines. If the throughput capacity is less than peak demand, knowledgeable passengers will extend their lead times. If possible and reasonably convenient, some passengers will change their transportation mode to a mode less affected by the constraint.

Note that automobile parking demand and any associated constraints will have a different profile than other landside facilities. Parking is a function of cumulative demand rather than peak demand. Therefore, at many airports with a strong business passenger component, parking demand (number of spaces occupied) tends to peak during the middle of the week when the majority of resident business travelers are away, even though passenger enplanement and deplanement activity tends to be low at that time.

9.4 Policy Constraints

Policy constraints can be grouped into two general categories, direct and indirect. Examples of the former would be slot controls or noise curfews, wherein activity levels are directly spelled out. Indirect constraints would include restrictions that limit, but do not eliminate, the ability of airlines to operate during sensitive timeframes such as times of congestion or nighttime. Examples of indirect constraints include peak period pricing or noise budgets.

9.4.1 Direct Policy Constraints

At first glance, peak period or operational profiles would appear to be easy to estimate by simply defining the peak period as the regulated limit. However, even with rigorous hourly slot systems, airlines have latitude to schedule at different times within an hour, so peak periods may vary within an hour. As noted earlier, the peak 60-minute period often differs from the peak clock hour, and slot restrictions typically apply to the clock hour.

In these instances, it is advisable to use the approach discussed in Chapter 8 for peak period operations. The effects of the slot system will be reflected in the distribution of daily operations; the remaining steps will be the same as in unconstrained airports. Note that in some instances, the restrictions do not apply to off-peak hours.

Strict noise curfews restrict the operations occurring during sensitive nighttime hours which may or may not correspond to the INM definition of night (10 PM to 7 AM). Typically, noise curfews do not apply until 11:00 PM or later, so there is still potential for nighttime operations. The approaches in Chapter 7 can be used to estimate day/night splits even with a noise curfew, but the impact of the noise curfew will need to be evaluated when developing assumptions on the expected increase or decrease in the percentage of nighttime operations. Airports with slot restrictions constrain activity during peak hours which typically occur during the day and therefore are more likely to shift activity to the nighttime than at an unconstrained airport. This should be taken into account when preparing assumptions on the increase or decrease of nighttime operations.

9.4.2 Indirect Constraints

The impact of congestion pricing initiatives on peak hour operations and operational profiles can theoretically be modeled by estimating airline elasticities of aircraft operations to operational costs. In this instance, the elasticity represents the percentage decrease in aircraft operations with each one percent increase in operational costs including landing fees. This may not work in reality, since cost concerns associated with a single aircraft operation may be superseded by network concerns and competitive factors. Assuming the anticipated congestion pricing initiative has adequate flexibility, identifying or estimating the congestion reduction goals and assuming that the pricing mechanism will be adjusted to meet those goals may be a more effective way of estimating peak period activity levels.

Noise budgets typically involve a fixed noise energy allowance which airlines cannot exceed, but have the flexibility of accommodating with either a few relatively noisy aircraft or a greater number of quieter aircraft. Forecasting operations in the times affected by the noise budget will require knowledge of future airline fleet plans and the noise characteristics of individual aircraft types. It is recommended that the planner consider surveying or interviewing the airlines to obtain their input.

9.5 Comments and Cautions

When preparing constrained operational profiles or peak period estimates, the following should be considered:

- At present, slot controls are the only demand management tools in use in the United States, and only at a very limited number of airports because they must be authorized by the federal government. As a result of recent regulatory revisions, airports will soon have a greater menu of options to choose from when managing demand. The impacts on aircraft operation and passenger profiles will vary depending on the type of tool used. As of yet, there is no empirical base that can be used to estimate and calibrate airline and passenger reactions to new demand management tools.

- The FAA is becoming increasingly sophisticated in the real-time management of demand. For example, gate holds (aircraft instructed to remain at the gate by FAA air traffic control) are now employed when the FAA anticipates more airspace congestion than can be accommodated.
- In adverse weather, airlines will often cancel flights rather than accept extensive delay. This means that in some instances, operational profiles during adverse weather (IFR conditions) will contain fewer operations than operational profiles in good weather (VFR conditions) during the same time of year. Tower data can be used to estimate which types of flights tend to be cancelled under these conditions.

Addressing these issues is complex and highly dependent on the particular airport and constraint type. It may be beneficial to have professional consulting services analyze those types of changes.

Endnotes

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[iii] FAA, *Emissions and Dispersion Modeling System (EDMS) User's Manual, FAA-AEE-07-01,* Federal Aviation Administration, Washington, D.C., September 19, 2008.

[iv] Ashford, N., Stanton, H. P. M., and Moore, C. A., *Airport Operations, 2nd edition,* McGraw-Hill Professional, New York, NY, 1996, p. 32.

[v] FAA, *Airport Master Plans, Advisory Circular No: 150/5070-6B,* Federal Aviation Administration, Washington, D.C., July 29, 2005, p. 49.

[vi] FAA, *Airport Capacity and Delay, Advisory Circular No: 150/5060,* Federal Aviation Administration, Washington, D.C., September 23, 1983.

[vii] Cheryl B. Scaparrotta, *Travel Forecasting Takes Off,* The MITRE Digest, March 25, 2008 http://www.mitre.org/news/digest/aviation/03_08/av_fate.html accessed August 21, 2009, and 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.

[viii] Chen, X. and J. Gulding, *Assessment of System Constraints for Producing Constrained Feasible Schedules,* Federal Aviation Administration, Washington, D.C., June 6, 2008.

[ix] 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.

[x] Chen, X. and J. Gulding, *Assessment of System Constraints for Producing Constrained Feasible Schedules,* Federal Aviation Administration, Washington, D.C., June 6, 2008.

[xi] SH&E, *San Diego International Airport Aviation Activity Forecasts,* San Diego, CA, June 2004, and 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.

APPENDIX A

Guidelines for Preparing Peak Period and Operational Profiles Manual for Toolboxes

A.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.

A.2 Aircraft Operations Module

The aircraft operations manual includes an introductory worksheet, two input worksheets and six output worksheets.

A.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 A.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.

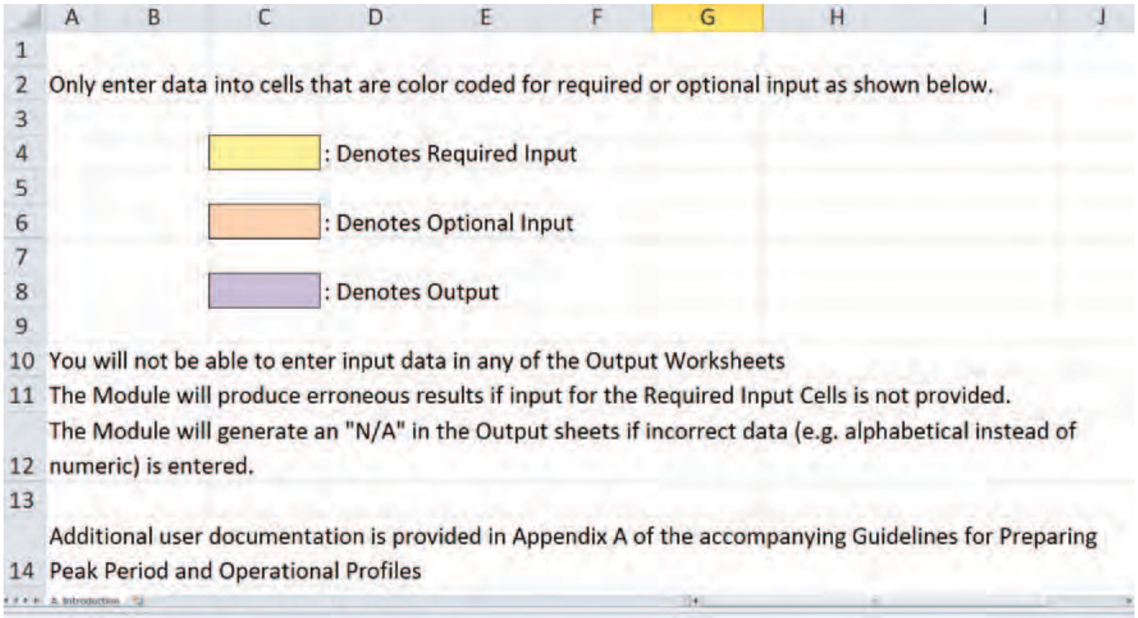
A.2.2 Input Worksheets

The first input worksheet, *B. User Parameters* (see Exhibit A.2), provides an opportunity for the user to provide input parameters to be tested.

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 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 (ADPM) 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

Exhibit A.1



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 ADPM 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 A.3), is where the base year data is entered.

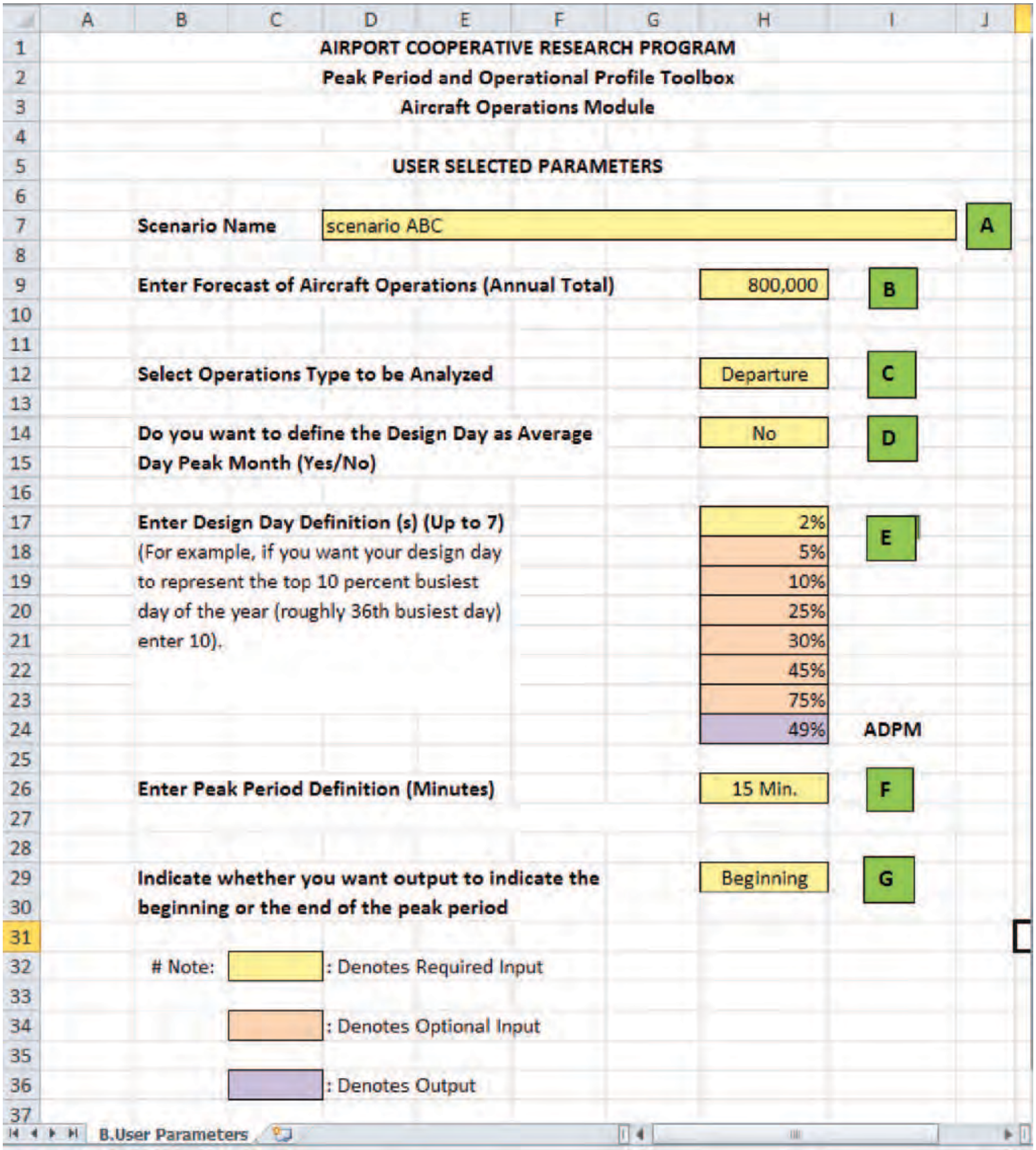
The user will need to enter complete aircraft operations data for a representative day in columns A through D. The following data should be entered:

- 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.

Exhibit A.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

B.User Parameters

Exhibit A.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

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.

A.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 A.4).

Exhibit A.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%**

D.Design Day

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 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 scenarios.

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 A.5).

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 A.6).

Exhibit A.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			Forecast Year		
Design Day Profile			**Future Design Day Profile**		
Departures			**Departures**		
Hour	Op Count by Hour Bucket (Whole Day)	%	Hour	Op Count by Hour Bucket (Whole Day)	%
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%

Departures			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%**

Exhibit A.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 — Design Day Profile — Departures

Hour	Op Count by Hour Bucket (Whole Day)	%
00:00-00:59	3	0.6%
01:00-01:59	3	0.6%
02:00-02:59	-	0.0%
03:00-03:59	-	0.0%
04:00-04:59	-	0.0%
05:00-05:59	7	1.1%
06:00-06:59	34	5.7%
07:00-07:59	31	5.1%
08:00-08:59	52	8.5%
09:00-09:59	19	3.1%
10:00-10:59	16	2.6%
11:00-11:59	22	3.7%
12:00-12:59	34	5.7%
13:00-13:59	38	6.3%
14:00-14:59	40	6.6%
15:00-15:59	24	4.0%
16:00-16:59	81	13.4%
17:00-17:59	59	9.7%
18:00-18:59	43	7.1%
19:00-19:59	36	6.0%
20:00-20:59	43	7.1%
21:00-21:59	9	1.4%
22:00-22:59	9	1.4%
23:00-23:59	2	0.3%
Total:	604	100.0%

Forecast Year (w/ Peak Spreading) — Future Design Day Profile — Departures

Hour	Op Count by Hour Bucket (Whole Day)	%
00:00-00:59	22	1.6%
01:00-01:59	22	1.6%
02:00-02:59	-	0.0%
03:00-03:59	-	0.0%
04:00-04:59	-	0.0%
05:00-05:59	28	2.0%
06:00-06:59	76	5.5%
07:00-07:59	70	5.0%
08:00-08:59	106	7.6%
09:00-09:59	49	3.5%
10:00-10:59	43	3.1%
11:00-11:59	55	4.0%
12:00-12:59	76	5.5%
13:00-13:59	82	5.9%
14:00-14:59	85	6.1%
15:00-15:59	58	4.2%
16:00-16:59	157	11.3%
17:00-17:59	118	8.5%
18:00-18:59	91	6.5%
19:00-19:59	79	5.7%
20:00-20:59	91	6.5%
21:00-21:59	31	2.2%
22:00-22:59	31	2.2%
23:00-23:59	19	1.4%
Total:	1,397	100.0%

Base Year — Departures

Peak Value:	81	16:00
Peak Hour:	16:00-16:59	13.4%

Forecast Year — Departures

Peak Value:	157	16:00
Peak Hour:	16:00-16:59	11.3%

Base Year Annual Operations	345,948
Forecast Year Annual Operations	800,000
Design Day Definition	2%

F. Design Day Profile - Spread

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 Exhibit A.7, the user selected a 15 minute peak period definition; the peak 15 minute operations during the two percent busiest day in the forecast year are estimated at 83 operations (A). This worksheet assumes no peak spreading.

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 A.8, peak 15 minute operations during the two percent busiest day in the forecast year are estimated at 70 operations (B).

Exhibit A.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 — **Peak Period in Design Day**

Departures

Selected top X % busiest day	Rank	Rolling 15 min
ADPM	179	29
2%	7	36
5%	17	34
10%	36	33
25%	89	32
30%	109	31
45%	164	30
75%	272	25

Departures

Peak Period Definition	Clock Time*
Rolling 15 min	16:41

Forecast Year — **Future Peak Period in Design Day**

Departures

Selected top X % busiest day	Rank	Rolling 15 min	
ADPM	179	69	
2%	7	83	A
5%	17	80	
10%	36	78	
25%	89	74	
30%	109	73	
45%	164	70	
75%	272	59	

Departures

Peak Period Definition	Clock Time*
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%

G. Peak Period

Exhibit A.8

AIRPORT COOPERATIVE RESEARCH PROGRAM
Peak Period and Operational Profile Toolbox
Aircraft Operations Module

PEAK PERIOD ESTIMATES
(Assumes Peak Spreading)
scenario ABC

Base Year

Peak Period in Design Day

Departures

Selected top X % busiest day	Rank	Rolling 15 min
ADPM	179	29
2%	7	36
5%	17	34
10%	36	33
25%	89	32
30%	109	31
45%	164	30
75%	272	25

Departures

Peak Period definition	Clock Time*
Rolling 15 min	16:41

Forecast Year (w/ Peak Spreading)

Future Peak Period in Design Day

Departures

Selected top X % busiest day	Rank	Rolling 15 min
ADPM	179	58
2%	7	70
5%	17	67
10%	36	66
25%	89	62
30%	109	61
45%	164	59
75%	272	50

B

Departures

Peak Period definition	Clock Time*
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%

Peak Period - Spread

The final output spreadsheet (Exhibit A.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.

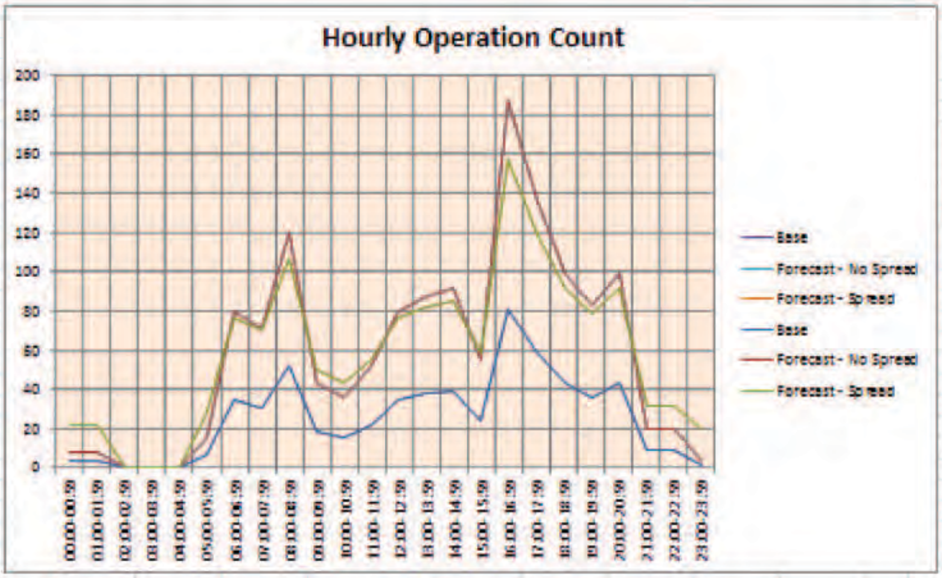
A.3 Passenger Module

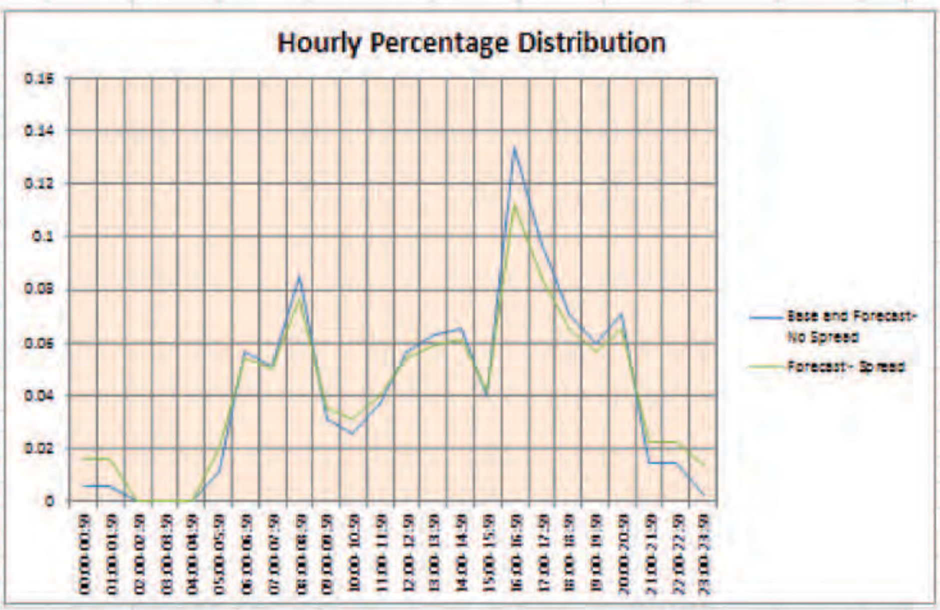
The passenger module of the Toolbox consists of an introductory worksheet, two input worksheets, and nine output worksheets. The format is similar to the operations manual but contains more features.

Exhibit A.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 Oper:	345,948
Forecast Year Annual O	800,000
Design Day Definition	2%

I. Charts - Design Day Profile

A.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.

A.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 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.
- Determine if the ADPM 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 A.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 × 2 percent).

Exhibit A.10

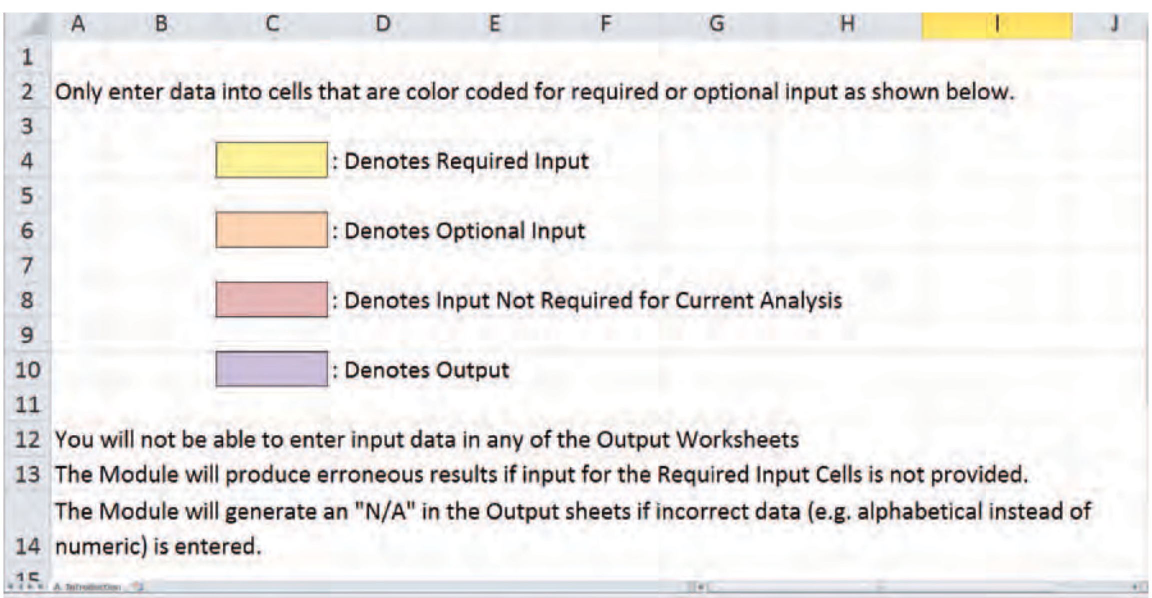
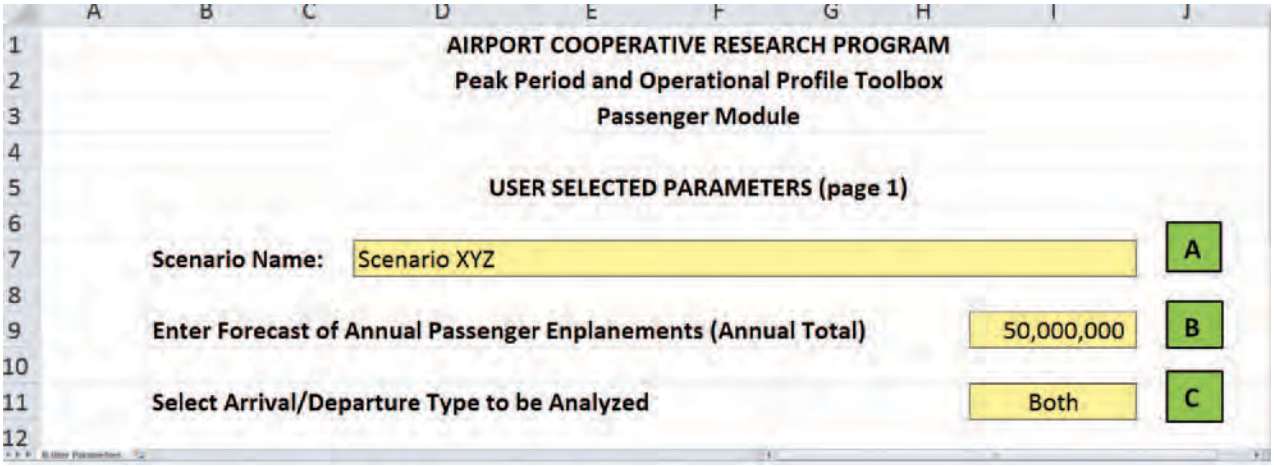

A B C D E F G H I J
1
2 Only enter data into cells that are color coded for required or optional input as shown below.
3
4 : Denotes Required Input
5
6 : Denotes Optional Input
7
8 : Denotes Input Not Required for Current Analysis
9
10 : Denotes Output
11
12 You will not be able to enter input data in any of the Output Worksheets
13 The Module will produce erroneous results if input for the Required Input Cells is not provided.
14 The Module will generate an "N/A" in the Output sheets if incorrect data (e.g. alphabetical instead of numeric) is entered.
15

Exhibit A.11



- 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 A.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 provides suggestions on appropriate peak period definitions by facility category.
- 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 A.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).
- Provide monthly enplanement data for each month for the airport being analyzed (H) (see Exhibit A.15).
- 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 A.12

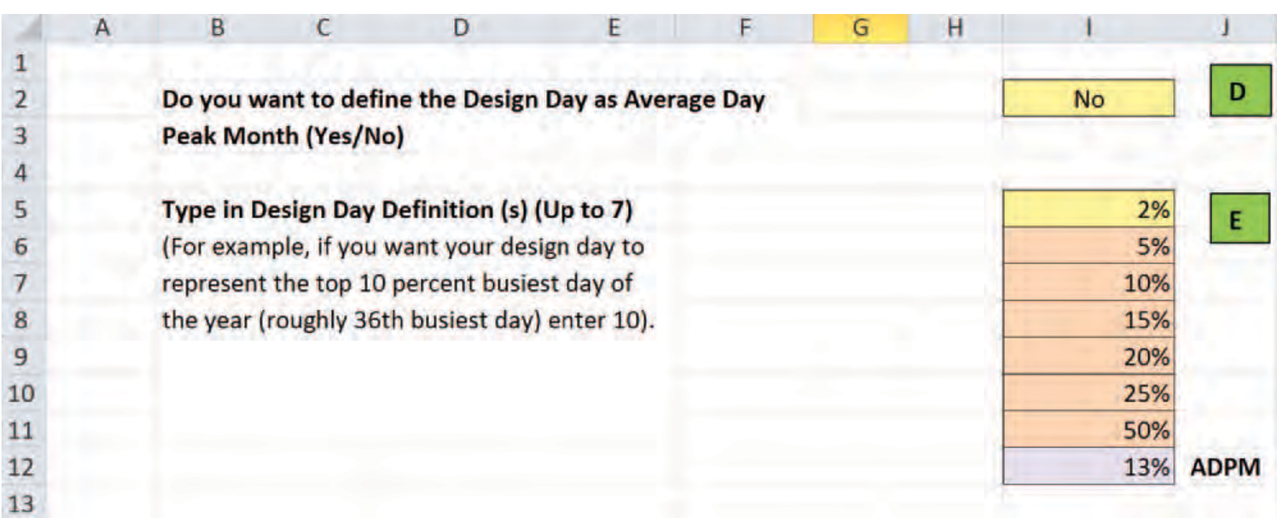


Exhibit A.13

Enter Peak Period Definition (Minutes)	15 Min.	

Exhibit A.14

Indicate whether you want output to indicate the beginning or the end of the peak period	End	F
Enter Date for Input Schedule Data	11/11/2011	G

Exhibit A.15

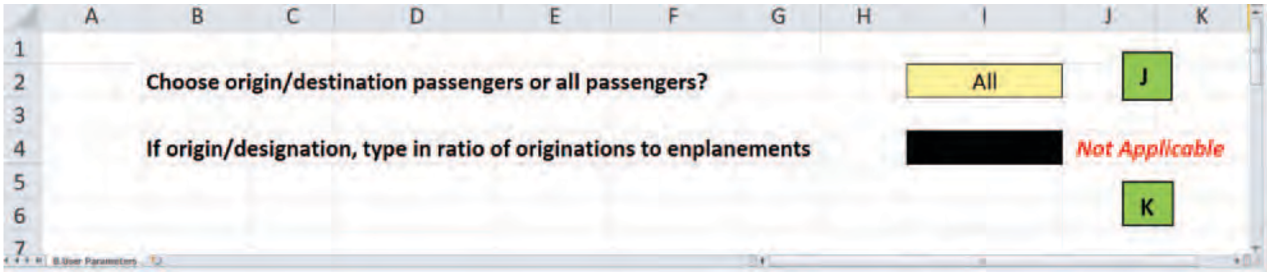
Enter Monthly Enplanements for Base Year (Each Month) H

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

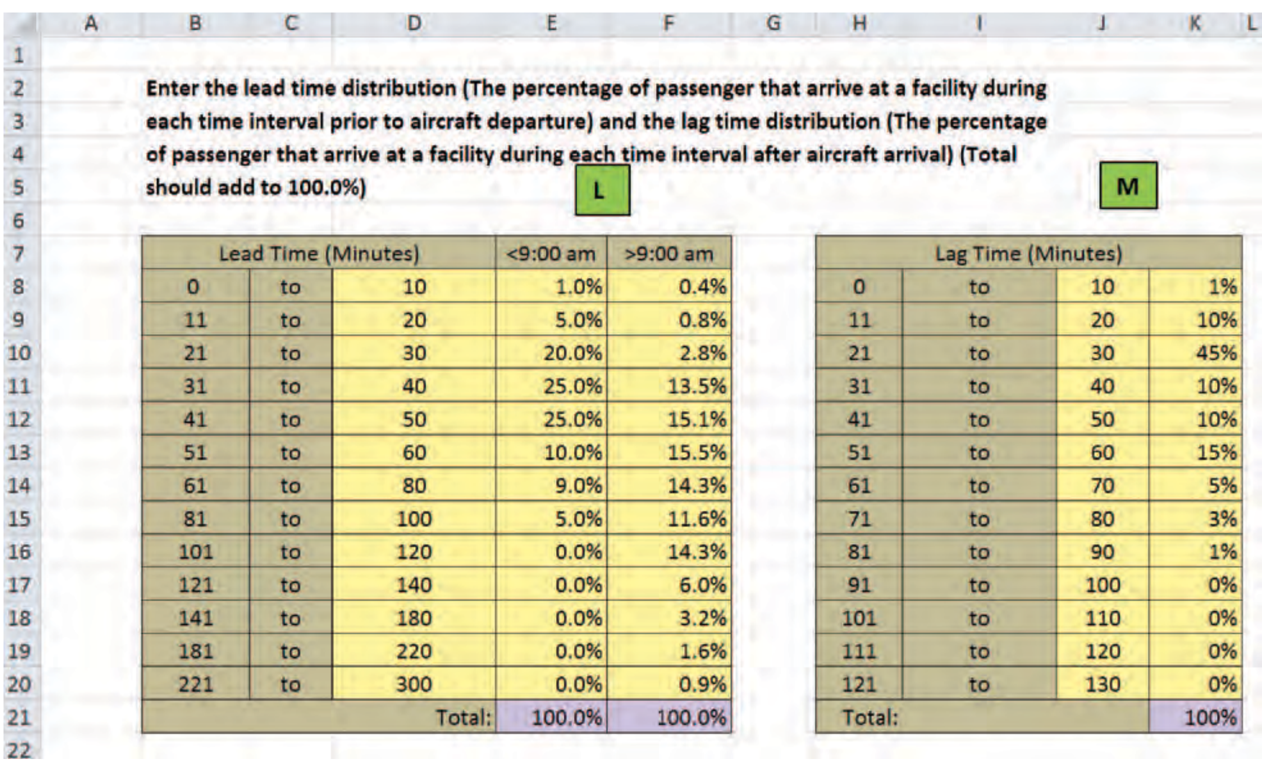
Day of Week Load Factor		
Sun	1	1.020
Mon	2	1.200
Tue	3	1.035
Wed	4	1.039
Thu	5	1.033
Fri	6	1.034
Sat	7	0.850

Exhibit A.16



- Determine whether to analyze O&D 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 A.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 A.16 because "All" was selected.
- Provide the lead and/or lag time distributions. Since both arrivals and departures were selected (see Exhibit A.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 Exhibit A.17, before 9:00 am, one percent of enplaning

Exhibit A.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%

passengers arrive 10 minutes or less prior to scheduled aircraft departure, and five percent of enplaning passengers arrive between 10 and 20 minutes prior to departure. Also, one percent of deplaning passengers arrive at the facility 10 minutes after aircraft arrival and 10 percent 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.

The second input sheet, *C. Base Year Data* (see Exhibit A.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 A.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

C.Base Year Data

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.

A.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 ADPM and AAD passengers.

In the example in Exhibit A.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.

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 A.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).

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 A.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.

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 A.22).

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 A.23).

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

Exhibit A.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

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 =	56,791,145
Average Annual Day (ADD) Total =	155,592

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%

D. Design Day

below, the user selected a 60 minute peak period definition. In the example in Exhibit A.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 A.22). This worksheet assumes no peak spreading.

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 A.25, peak 60 minute passengers during the two percent busiest day in the forecast year are estimated at 31,652 passengers.

The final two worksheets, *K. Charts—Design Day Profile,* and *L. Charts—Derivative Profiles,* provide graphic representations of the results. Worksheet K (Exhibit A.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 A.27) provides a graphic representation of the derivative profile for each of the three cases.

Exhibit A.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 — Design Day Profile

Hour	Passengers by Hour	Percent
00:00-00:59	810	0.4%
01:00-01:59	671	0.3%
02:00-02:59	326	0.2%
03:00-03:59	739	0.3%
04:00-04:59	1,108	0.5%
05:00-05:59	687	0.3%
06:00-06:59	3,929	1.9%
07:00-07:59	11,350	5.4%
08:00-08:59	12,713	6.0%
09:00-09:59	13,690	6.5%
10:00-10:59	17,355	8.2%
11:00-11:59	14,625	6.9%
12:00-12:59	13,589	6.4%
13:00-13:59	8,823	4.2%
14:00-14:59	10,963	5.2%
15:00-15:59	11,378	5.4%
16:00-16:59	11,544	5.5%
17:00-17:59	14,417	6.8%
18:00-18:59	13,606	6.4%
19:00-19:59	14,663	6.9%
20:00-20:59	13,101	6.2%
21:00-21:59	7,673	3.6%
22:00-22:59	7,723	3.7%
23:00-23:59	6,018	2.8%
Total:	211,500	100.0%

Peak Value:	17,355	10:00
Peak Hour:	10:00-10:59	8.21%

Forecast Year — Future Design Day Profile

Hour	Passengers by Hour	Percent
00:00-00:59	1,427	0.4%
01:00-01:59	1,181	0.3%
02:00-02:59	575	0.2%
03:00-03:59	1,302	0.3%
04:00-04:59	1,951	0.5%
05:00-05:59	1,209	0.3%
06:00-06:59	6,919	1.9%
07:00-07:59	19,986	5.4%
08:00-08:59	22,385	6.0%
09:00-09:59	24,105	6.5%
10:00-10:59	30,559	8.2%
11:00-11:59	25,751	6.9%
12:00-12:59	23,928	6.4%
13:00-13:59	15,535	4.2%
14:00-14:59	19,304	5.2%
15:00-15:59	20,035	5.4%
16:00-16:59	20,326	5.5%
17:00-17:59	25,386	6.8%
18:00-18:59	23,957	6.4%
19:00-19:59	25,819	6.9%
20:00-20:59	23,070	6.2%
21:00-21:59	13,511	3.6%
22:00-22:59	13,600	3.7%
23:00-23:59	10,596	2.8%
Total:	372,416	100.0%

Peak Value:	30,559	10:00
Peak Hour:	10:00-10:59	8.21%

Base Year Annual Passenger Enplanements	28,371,238
Forecast Year Annual Passenger Enplanements	50,000,000
Design Day Definition	2%

Exhibit A.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

Design Day Derivative Profile

Hour	Passengers by Hour	Percent
00:00-00:59	4,412	2.1%
01:00-01:59	569	0.3%
02:00-02:59	375	0.2%
03:00-03:59	450	0.2%
04:00-04:59	1,256	0.6%
05:00-05:59	3,395	1.6%
06:00-06:59	5,004	2.4%
07:00-07:59	11,201	5.3%
08:00-08:59	12,826	6.1%
09:00-09:59	15,784	7.5%
10:00-10:59	18,626	8.8%
11:00-11:59	14,470	6.8%
12:00-12:59	10,060	4.8%
13:00-13:59	9,488	4.5%
14:00-14:59	11,208	5.3%
15:00-15:59	11,024	5.2%
16:00-16:59	10,752	5.1%
17:00-17:59	16,666	7.9%
18:00-18:59	14,943	7.1%
19:00-19:59	10,847	5.1%
20:00-20:59	11,767	5.6%
21:00-21:59	10,331	4.9%
22:00-22:59	2,518	1.2%
23:00-23:59	3,528	1.7%
Total:	211,500	100.0%

Peak Value:	18,626	10:00
Peak Hour:	10:00-10:59	8.81%

Forecast Year

Future Design Day Derivative Profile

Hour	Passengers by Hour	Percent
00:00-00:59	7,769	2.1%
01:00-01:59	1,002	0.3%
02:00-02:59	660	0.2%
03:00-03:59	792	0.2%
04:00-04:59	2,212	0.6%
05:00-05:59	5,979	1.6%
06:00-06:59	8,811	2.4%
07:00-07:59	19,722	5.3%
08:00-08:59	22,584	6.1%
09:00-09:59	27,794	7.5%
10:00-10:59	32,797	8.8%
11:00-11:59	25,479	6.8%
12:00-12:59	17,715	4.8%
13:00-13:59	16,707	4.5%
14:00-14:59	19,735	5.3%
15:00-15:59	19,412	5.2%
16:00-16:59	18,932	5.1%
17:00-17:59	29,346	7.9%
18:00-18:59	26,312	7.1%
19:00-19:59	19,100	5.1%
20:00-20:59	20,719	5.6%
21:00-21:59	18,191	4.9%
22:00-22:59	4,433	1.2%
23:00-23:59	6,213	1.7%
Total:	372,416	100.0%

Peak Value:	32,797	10:00
Peak Hour:	10:00-10:59	8.81%

Base Year Annual Passenger Enplanements	28,371,238
Forecast Year Annual Passenger Enplanements	50,000,000
Design Day Definition	2%

F. Derivative Profile - NS

Exhibit A.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	810	0.4%	00:00-00:59	4,180	1.1%
01:00-01:59	671	0.3%	01:00-01:59	3,982	1.1%
02:00-02:59	326	0.2%	02:00-02:59	3,494	0.9%
03:00-03:59	739	0.3%	03:00-03:59	4,079	1.1%
04:00-04:59	1,108	0.5%	04:00-04:59	4,601	1.2%
05:00-05:59	687	0.3%	05:00-05:59	4,004	1.1%
06:00-06:59	3,929	1.9%	06:00-06:59	8,599	2.3%
07:00-07:59	11,350	5.4%	07:00-07:59	19,113	5.1%
08:00-08:59	12,713	6.0%	08:00-08:59	21,043	5.7%
09:00-09:59	13,690	6.5%	09:00-09:59	22,427	6.0%
10:00-10:59	17,355	8.2%	10:00-10:59	27,621	7.4%
11:00-11:59	14,625	6.9%	11:00-11:59	23,752	6.4%
12:00-12:59	13,589	6.4%	12:00-12:59	22,284	6.0%
13:00-13:59	8,823	4.2%	13:00-13:59	15,532	4.2%
14:00-14:59	10,963	5.2%	14:00-14:59	18,564	5.0%
15:00-15:59	11,378	5.4%	15:00-15:59	19,152	5.1%
16:00-16:59	11,544	5.5%	16:00-16:59	19,387	5.2%
17:00-17:59	14,417	6.8%	17:00-17:59	23,458	6.3%
18:00-18:59	13,606	6.4%	18:00-18:59	22,308	6.0%
19:00-19:59	14,663	6.9%	19:00-19:59	23,806	6.4%
20:00-20:59	13,101	6.2%	20:00-20:59	21,594	5.8%
21:00-21:59	7,673	3.6%	21:00-21:59	13,903	3.7%
22:00-22:59	7,723	3.7%	22:00-22:59	13,974	3.8%
23:00-23:59	6,018	2.8%	23:00-23:59	11,558	3.1%
Total:	211,500	100.0%	Total:	372,416	100.0%

Peak Value:	17,355	10:00	Peak Value:	27,621	10:00
Peak Hour:	10:00-10:59	8.21%	Peak Hour:	10:00-10:59	7.42%

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

Exhibit A.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

Design Day Derivative Profile

Hour	Passengers by Hour	%
00:00-00:59	4,412	2.1%
01:00-01:59	569	0.3%
02:00-02:59	375	0.2%
03:00-03:59	450	0.2%
04:00-04:59	1,256	0.6%
05:00-05:59	3,395	1.6%
06:00-06:59	5,004	2.4%
07:00-07:59	11,201	5.3%
08:00-08:59	12,826	6.1%
09:00-09:59	15,784	7.5%
10:00-10:59	18,626	8.8%
11:00-11:59	14,470	6.8%
12:00-12:59	10,060	4.8%
13:00-13:59	9,488	4.5%
14:00-14:59	11,208	5.3%
15:00-15:59	11,024	5.2%
16:00-16:59	10,752	5.1%
17:00-17:59	16,666	7.9%
18:00-18:59	14,943	7.1%
19:00-19:59	10,847	5.1%
20:00-20:59	11,767	5.6%
21:00-21:59	10,331	4.9%
22:00-22:59	2,518	1.2%
23:00-23:59	3,528	1.7%
Total:	211,500	100.0%

Peak Value:	18,626	10:00
Peak Hour:	10:00-10:59	8.81%

Forecast Year (w/ Peak Spreading)

Future Design Day Derivative Profile

Hour	Passengers by Hour	After adjust (%)
00:00-00:59	9,283	2.5%
01:00-01:59	3,838	1.0%
02:00-02:59	3,562	1.0%
03:00-03:59	3,669	1.0%
04:00-04:59	4,811	1.3%
05:00-05:59	7,842	2.1%
06:00-06:59	10,121	2.7%
07:00-07:59	18,901	5.1%
08:00-08:59	21,204	5.7%
09:00-09:59	25,395	6.8%
10:00-10:59	29,421	7.9%
11:00-11:59	23,533	6.3%
12:00-12:59	17,285	4.6%
13:00-13:59	16,474	4.4%
14:00-14:59	18,911	5.1%
15:00-15:59	18,651	5.0%
16:00-16:59	18,265	4.9%
17:00-17:59	26,644	7.2%
18:00-18:59	24,203	6.5%
19:00-19:59	18,400	4.9%
20:00-20:59	19,703	5.3%
21:00-21:59	17,669	4.7%
22:00-22:59	6,599	1.8%
23:00-23:59	8,031	2.2%
Total:	372,416	100.0%

Peak Value:	29,421	10:00
Peak Hour:	10:00-10:59	7.90%

Base Year Annual Passenger Enplanements	28,371,238
Forecast Year Annual Passenger Enplanements	50,000,000
Design Day Definition	2%

H.Derivative Profile - PS

Exhibit A.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

Peak Period in Design Day

Selected top X % busiest day	Rank	Rolling 60 min
ADPM	47	16472
2%	7	18807
5%	18	17262
10%	36	16736
15%	54	16403
20%	73	16038
25%	91	15520
50%	182	13810

Peak Period definition	Clock Time*
Rolling 60 min	11:21

Forecast Year

Future Peak Period in Design Day

Selected top X % busiest day	Rank	Rolling 60 min
ADPM	47	29004
2%	7	33116
5%	18	30397
10%	36	29469
15%	54	28884
20%	73	28240
25%	91	27329
50%	182	24317

Peak Period definition	Clock Time*
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%

Exhibit A.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

Peak Period in Design Day

Selected top X % busiest day	Rank	Rolling 60 min
ADPM	47	16472
2%	7	18807
5%	18	17262
10%	36	16736
15%	54	16403
20%	73	16038
25%	91	15520
50%	182	13810

Peak Period definition	Clock Time*
Rolling 60 min	11:21

Forecast Year (w/ Peak Spreading)

Future Peak Period in Design Day

Selected top X % busiest day	Rank	Rolling 60 min
ADPM	47	26215
2%	7	29931
5%	18	27474
10%	36	26635
15%	54	26106
20%	73	25524
25%	91	24701
50%	182	21978

Peak Period definition	Clock Time*
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%

J. Peak Period - PS

Exhibit A.26

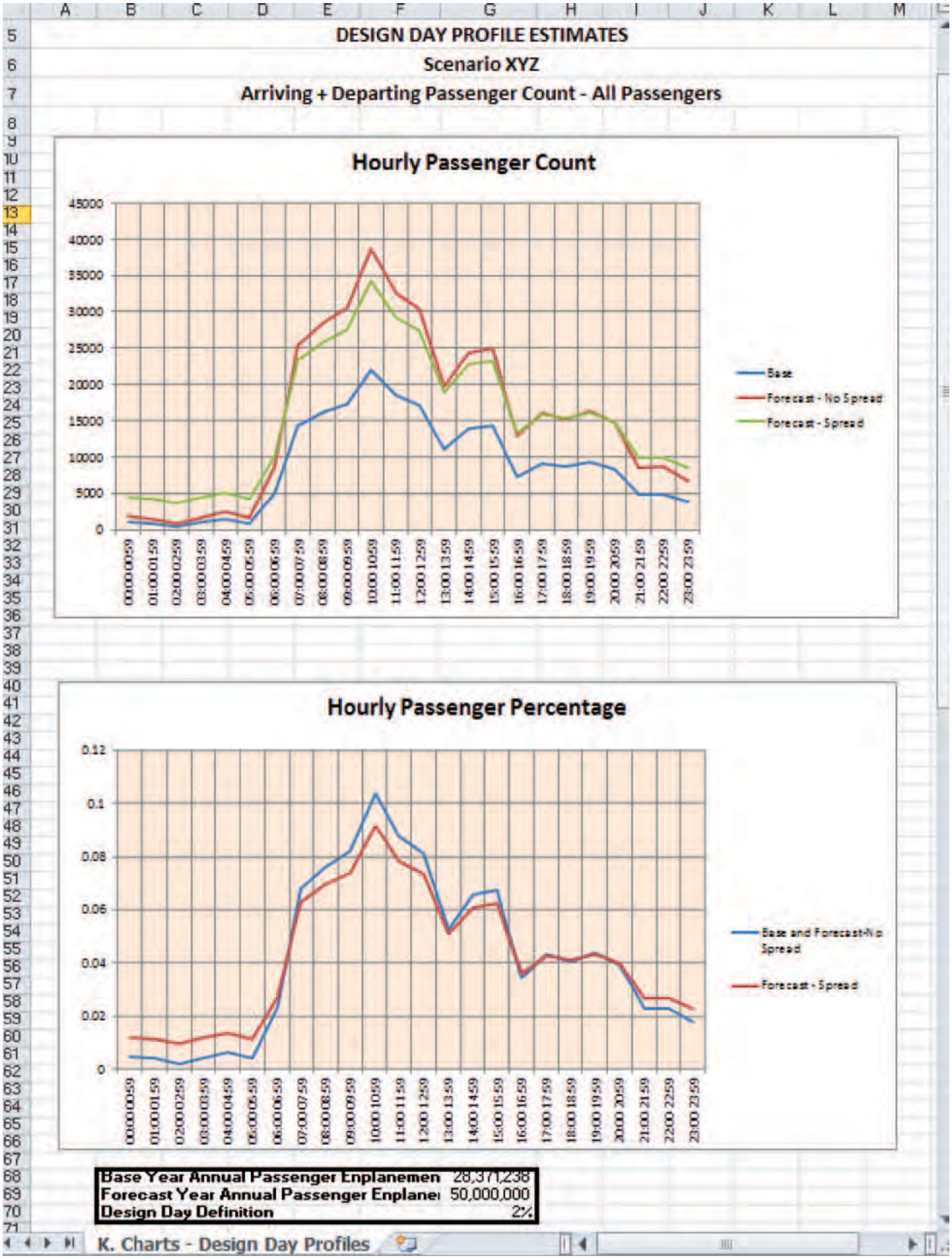
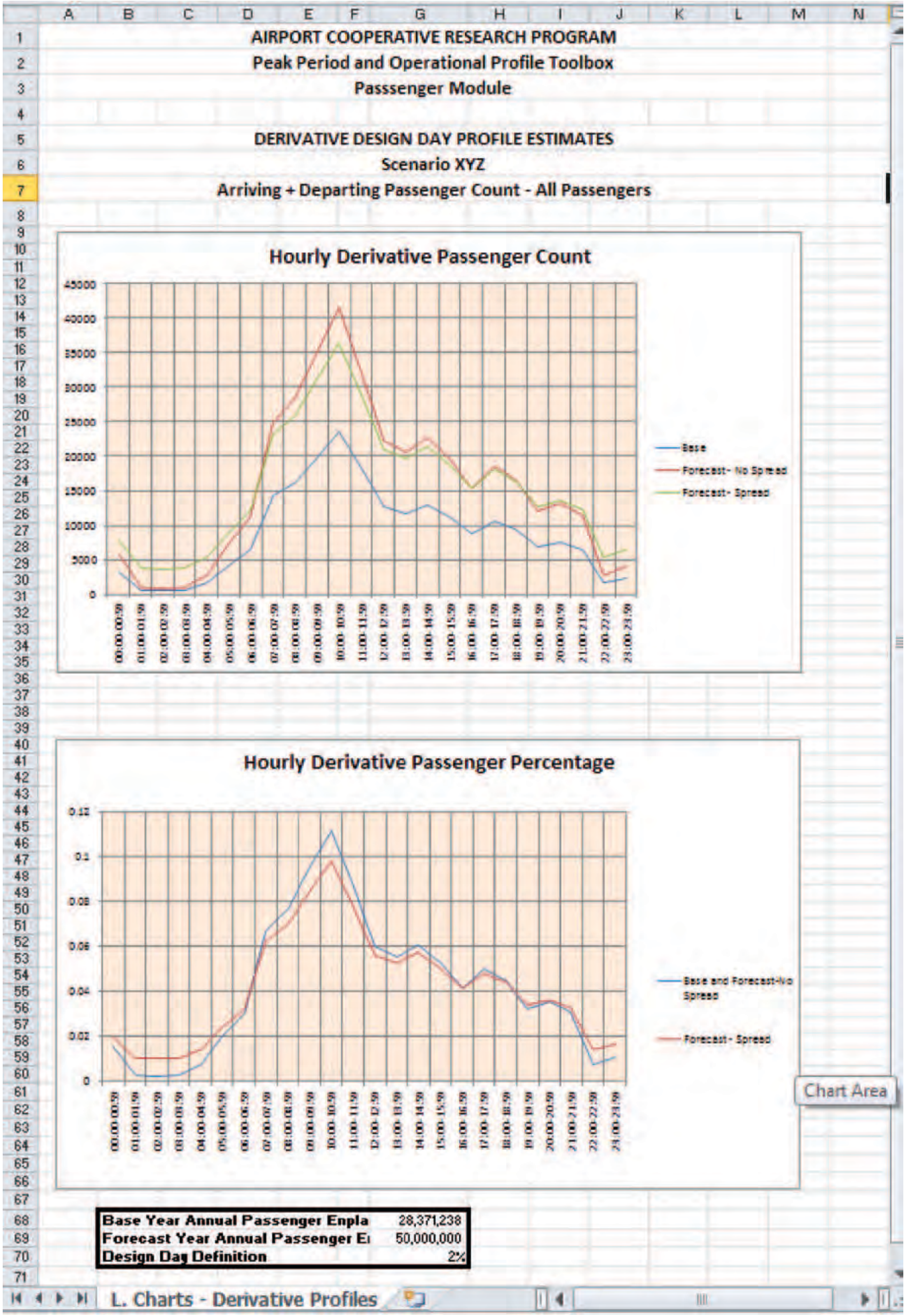

DESIGN DAY PROFILE ESTIMATES
Scenario XYZ
Arriving + Departing Passenger Count - All Passengers
Hourly Passenger Count
Base
Forecast - No Spread
Forecast - Spread
Hourly Passenger Percentage
Base and Forecast-No Spread
Forecast - Spread
Base Year Annual Passenger Enplanemen 28,371,238
Forecast Year Annual Passenger Enplane 50,000,000
Design Day Definition 2%
K. Charts - Design Day Profiles

Exhibit A.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
Chart Area
Base Year Annual Passenger Enpla 28,371,238
Forecast Year Annual Passenger E 50,000,000
Design Day Definition 2%
L. Charts - Derivative Profiles

APPENDIX B

Sources of Data

This appendix provides a listing of data that is useful for the preparation of peak period and operational profile estimates. Included are potential sources for the data, a description of the type of data and the level of detail that is provided, and any costs or restrictions that are associated.

B.1. Aircraft Operations Data

Each aircraft takeoff and landing is counted as an aircraft operation. The primary source of aircraft operations data is ATCT counts, which can be provided at varying levels of detail. Additional sources such as the Official Airline Guide and U.S. Department of Transportation Form 41 data are also available. Small airports without air traffic control towers typically do not record operations data. In those instances, operations data can be supplemented with acoustical counters, either year round or for representative periods, to assemble estimates of annual, busy, and peak period activity. Following are descriptions of potential secondary sources of aircraft operations data.

Official Airline Guide (OAG)

Sources	Official Airline Guide http://www.oagaviation.com/ Data Base Products, Inc. http://www.airlinedata.com/
Types of Data	Published commercial airline schedule information including the published carrier, operating carrier (which may differ from the published carrier under code-sharing agreements), flight number, aircraft type, origin and destination, flight itinerary, scheduled time of flight (departing and arriving at gate), and frequency during the week.
Level of Detail	Disaggregated to the individual flight level.
Costs/Restrictions	Includes no data for aircraft operators that do not publish a schedule. Vendors charge a fee to provide data.

FAA Operations Network (OPSNET)

Sources	FAA Operations and Performance website http://aspm.faa.gov/
Types of Data	Provides data on operations for all FAA and FAA-contracted towered airports in the United States. Operations are organized according to six categories: air carrier, air taxi, itinerant general aviation, local general aviation, itinerant military, and local military. IFR and VFR operations are included. Detailed delay data is also included.
Level of Detail	Available on a daily, monthly, or annual basis, but is not on an hourly basis.
Costs/Restrictions	Password restricted. Password must be obtained from FAA.

FAA Air Traffic Activity System (ATADS)

Sources	FAA Operations and Performance website http://aspm.faa.gov/
Types of Data	Provides data on operations for all FAA and FAA-contracted towered airports in the United States. Operations are organized according to six categories: air carrier, air taxi, itinerant general aviation, local general aviation, itinerant military, and local military. IFR and VFR operations are included.
Level of Detail	Available on a daily, monthly, or annual basis, but is not on an hourly basis.
Costs/Restrictions	None.

Enhanced Traffic Management System (ETMS)

Sources	FAA Air Traffic Airspace Lab
Types of Data	ETMS contains individual flight information such as the date, time, aircraft identity (flight number or N-number).
Level of Detail	Disaggregated to the individual flight level.
Costs/Restrictions	Not generally available to the public. Requires special request from the FAA.

Enhanced Traffic Management System Counts (ETMSC)—Airport

Sources	FAA Operations and Performance website http://aspm.faa.gov/
Types of Data	Airport summary that includes counts by day, month, or year including aircraft type, and user group at towered airports.
Level of Detail	Available on a daily, monthly, or annual basis, but is not on an hourly basis.
Costs/Restrictions	Password restricted. Password must be obtained from FAA.

Enhanced Traffic Management System Counts (ETMSC)—Distributed OPSNET

Sources	FAA Operations and Performance website http://aspm.faa.gov/
Types of Data	OPSNET operations by arrival, departure, and hour at towered airports. Includes commercial (combined air carrier and air taxi) general aviation, and military.
Level of Detail	Available on an hourly, daily, monthly or annual basis.
Costs/Restrictions	Password restricted. Password must be obtained from FAA.

Performance Data Analysis and Decision System (PDARS)

Sources	FAA Office of System Capacity and NASA Aviation Safety Program
Types of Data	ETMS contains individual flight information such as the date, time, aircraft identity (flight number or N-number) and origin/destination
Level of Detail	Disaggregated to the individual flight level.
Costs/Restrictions	Not generally available to the public. Requires special request that the FAA must approve.

Airport Noise and Operations Monitoring System (ANOMS)

Sources	Individual airports that have had the system installed.
Types of Data	Individual flight information such as the date, time, aircraft identity (flight number or N-number).
Level of Detail	Disaggregated to the individual flight level.
Costs/Restrictions	Varies by airport.

B.2. Passenger Data

Passenger data can be broken out in many ways, by arrival (deplaning) or departure (enplaning), by local (origin/destination) or connecting, and by domestic or international origin and destination. Below is a listing of potential sources of passenger data.

Airline Origin and Destination Survey (DB1B, O&D Survey)

Sources Data Base Products, Inc. http://www.airlinedata.com/
Official Airline Guide, http://www.oagaviation.com/%20/Solutions/Analysis-Forecasting/OAG-Traffic-Performance-Analysis
Bureau of Transportation Statistics, Research and Innovative Technology Administration (RITA) http://transtats.bts.gov/Tables.asp?DB_ID=125&DB_Name=Airline%20Origin%20and%20Destination%20Survey%20%28DB1B%29&DB_Short_Name=Origin%20and%20Destination%20Survey

Types of Data 10 percent survey that contains the full routing for each passenger, including the origin, destination, and any connecting airports.

Level of Detail Airport, airline, and destination market by quarter and year.

Costs/Restrictions Available at no cost from RITA, vendors charge a fee. Only available for U.S.-flag carriers. To access international data requires special permission from USDOT.

Form 41 Traffic Statistics (T-100 Reports)

Sources Data Base Products, Inc. http://www.airlinedata.com/
Official Airline Guide, http://www.oagaviation.com/%20/Solutions/Analysis-Forecasting/OAG-Traffic-Performance-Analysis
Bureau of Transportation Statistics, Research and Innovative Technology Administration (RITA) http://transtats.bts.gov/Tables.asp?DB_ID=130&DB_Name=Air%20Carrier%20Summary%20Data%20%28Form%2041%20and%20298C%20Summary%20Data%29&DB_Short_Name=Air%20Carrier%20Summary

Types of Data Data on all passengers and cargo on U.S. and foreign flag carriers who are traveling on flight segments within the United States, and flight segments between the United States and foreign points provided by airport, airline, and equipment type.

Level of Detail Monthly and annual basis.

Costs/Restrictions Available at no cost from RITA, vendors charge a fee.

Marketing Information Data Transfer (MIDT) (Travel Agency booking data)

Sources The data is available for purchase through several different vendors.

Types of Data Booking data collected by flight coupon (flight segment, or boarding of an aircraft) so that the full routing is provided for each passenger, including the origin, destination, and any connecting airports.

Level of Detail Monthly and annual basis.

Costs/Restrictions Prices vary depending on the data requested.

IATA Billing and Settlement Plan (BSP) Data
(Foreign Point-of-Sale Travel Agency ticketing data)

Sources Available for purchase through an IATA-designated vendor.

Types of Data Ticketing data is collected by flight coupon (flight segment, or boarding of an aircraft) so that the full routing is provided for each passenger, including the origin, destination, and any connecting airports used.

Level of Detail Monthly and annual basis.

Costs/Restrictions Prices vary depending on the data requested.

Airline Reporting Corporation (ARC) Data (U.S. Point-of-Sale Travel Agency ticketing data)

Sources Airline Reporting Corporation
http://arctravelcard.com/solutions/industry-analysis.jsp

Types of Data Ticketing data organized by flight coupon (flight segment, or boarding of an aircraft) so that the full routing is provided for each passenger, including the origin, destination, and any connecting airports used.

Level of Detail Available for specific travel dates and specific flight numbers.
Costs/Restrictions Prices vary depending on the data requested.

B.3. Annual Forecasts

In addition to the following TAF detailed, annual forecasts can be obtained from airport master plans or other planning studies, regional or state system plans, and private vendors. Additional discussion of annual forecasts is provided in Chapter 2 of this Guidebook.

FAA Terminal Area Forecast (TAF)
Sources FAA Operations and Performance website http://aspm.faa.gov/
Types of Data Enplanements for air carriers and regional carriers. Operations by Air Carrier, Commuter/Air Taxi, Itinerant and Local General Aviation, and Itinerant and Local Military.
Level of Detail Annual.
Costs/Restrictions None.

B.4. Summary of Applicable Data Sources

The following exhibits provide a summary of the data sources that are likely to be useful in the preparation of alternative peak period and operational profile estimates.

Exhibit B.1. Annual and monthly aircraft operations.

Activity Category	OAG	T-100	ATADS	ETMSC	Airport
Scheduled Passenger Carrier	F	F	T*	F*	I
Non-Scheduled Passenger Carrier		F	T*	F*	I
All-Cargo Carrier		F	T*	F*	I
Air Taxi			T*	F*	I
General Aviation			T*	F*	I
Military			T*	F*	I

F = Fleet mix detail
F*= Fleet mix detail for instrument operations at towered airports.
T* = Total operations at towered airports.
I = Intermittent – available at airports that compile radar data as part of their noise monitoring operations

Exhibit B.2. Daily aircraft operations.

Activity Category	OAG	T-100	ATADS	ETMSC	Airport
Scheduled Passenger Carrier	F		T*	T*	I
Non-Scheduled Passenger Carrier			T*	T*	I
All-Cargo Carrier			T*	T*	I
Air Taxi			T*	T*	I
General Aviation			T*	T*	I
Military			T*	T*	I

F = Fleet mix detail
F*= Fleet mix detail for instrument operations at towered airports.
T* = Total operations at towered airports.
I = Intermittent – available at airports that compile radar data as part of their noise monitoring operations

Exhibit B.3. Hourly aircraft operations.

Activity Category	OAG	T-100	ATADS	ETMSC	Airport
Scheduled Passenger Carrier	F			T*	I
Non-Scheduled Passenger Carrier				T*	I
All-Cargo Carrier				T*	I
Air Taxi				T*	I
General Aviation				T*	I
Military				T*	I

F = Fleet mix detail
F*= Fleet mix detail for instrument operations at towered airports.
T* = Total operations at towered airports.
I = Intermittent – available at airports that compile radar data as part of their noise monitoring operations

Exhibit B.4. Annual and monthly capacity (Seats for Passenger/ Payload Capacity for Cargo).

Activity Category	OAG	T-100	ATADS	ETMSC	Airport
Scheduled Passenger Carrier	F	F		F*	I
Non-Scheduled Passenger Carrier		F		F*	I
All-Cargo Carrier		F		F*	I
Air Taxi				F*	I
General Aviation				F*	I
Military				F*	I

F = Fleet mix detail
F*= Fleet mix detail for instrument operations at towered airports. Seats and payload capacity for each aircraft would need to be obtained from alternate sources.

Exhibit B.5. Daily aircraft capacity (Seats for Passenger/Payload Capacity for Cargo).

Activity Category	OAG	T-100	ATADS	ETMSC	Airport
Scheduled Passenger Carrier	F				I
Non-Scheduled Passenger Carrier					I
All-Cargo Carrier					I
Air Taxi					I
General Aviation					I
Military					I

F = Fleet mix detail
F*= Fleet mix detail for instrument operations at towered airports.
T* = Total operations at towered airports.
I = Intermittent – available at airports that compile radar data as part of their noise monitoring operations

Exhibit B.6. Hourly aircraft capacity (Seats for Passenger/Payload Capacity for Cargo).

Activity Category	OAG	T-100	ATADS	ETMSC	Airport
Scheduled Passenger Carrier	F				I
Non-Scheduled Passenger Carrier					I
All-Cargo Carrier					I
Air Taxi					I
General Aviation					I
Military					I

F = Fleet mix detail
F*= Fleet mix detail for instrument operations at towered airports.
T* = Total operations at towered airports.
I = Intermittent – available at airports that compile radar data as part of their noise monitoring operations

Exhibit B.7. Annual and monthly passengers/cargo.

Activity Category	OAG	T-100	ATADS	ETMSC	Airport
Scheduled Passenger Carrier		F			I
Non-Scheduled Passenger Carrier		F			I
All-Cargo Carrier		F			I
Air Taxi					I
General Aviation					I
Military					I

F = Fleet mix detail
F*= Fleet mix detail for instrument operations at towered airports.
T* = Total operations at towered airports.
I = Intermittent – available at airports that compile passenger and cargo statistics.

APPENDIX C

Default Factors

Table C.1. Index of enplaning and deplaning load factors (Seat Factors) by day of the week.

Index of Arriving (Deplaning) Seat Factors								
FAA Hub Size	Time Zone	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Large	Eastern	1.056	1.005	0.932	0.956	1.012	1.042	1.000
	Central	1.043	1.076	0.968	0.906	0.950	1.038	1.020
	Pacific	1.042	1.045	0.972	0.972	0.991	1.004	0.971
Medium	Eastern	1.021	1.001	0.945	0.953	1.004	1.042	1.037
	Central	1.046	1.083	0.953	0.933	0.970	1.040	0.973
Non	Eastern	0.793	0.856	0.908	1.088	1.089	1.131	1.150
	Central	1.073	1.092	0.968	0.941	0.894	1.039	1.013
Small	Eastern	1.036	1.020	0.949	0.950	0.992	1.055	0.997
	Central	1.042	1.020	0.989	0.964	0.982	1.036	0.966

Index of Departing (Enplaning) Seat Factors								
FAA Hub Size	Time Zone	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Large	Eastern	1.039	1.022	0.941	0.953	1.004	1.033	1.010
	Central	1.000	0.974	0.913	0.963	1.044	1.095	1.012
	Pacific	1.020	0.992	0.959	0.970	1.019	1.046	0.990
Medium	Eastern	1.063	1.011	0.942	0.962	1.006	1.022	0.994
	Central	1.030	0.992	0.910	0.962	1.070	1.079	0.956
Non	Eastern	1.107	1.177	1.047	0.909	0.802	0.909	1.013
	Central	0.908	0.923	0.957	1.046	1.121	1.056	0.999
Small	Eastern	1.031	1.014	0.946	0.957	1.003	1.065	0.984
	Central	1.033	0.964	0.953	1.020	1.033	1.038	0.962

Table C.1. (Continued).

		Index of Total (Deplaning and Enplaning Combined) Seat Factors						
FAA Hub Size	Time Zone	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Large	Eastern	1.048	1.014	0.937	0.955	1.008	1.038	1.005
	Central	1.022	1.025	0.941	0.935	0.997	1.067	1.016
	Pacific	1.031	1.019	0.966	0.971	1.005	1.025	0.981
Medium	Eastern	1.042	1.006	0.944	0.958	1.005	1.032	1.016
	Central	1.038	1.038	0.932	0.948	1.020	1.060	0.965
Non	Eastern	0.950	1.017	0.978	0.999	0.946	1.020	1.082
	Central	0.991	1.008	0.963	0.994	1.008	1.048	1.006
Small	Eastern	1.034	1.017	0.948	0.954	0.998	1.060	0.991
	Central	1.038	0.992	0.971	0.992	1.008	1.037	0.964

Notes: Sample includes data from airlines accounting for 20 to 30 percent of national enplanements and includes 59 airports.

Large Airport Hub - accounts for 1% or more of total U.S. passenger enplanements
Medium Airport Hub - accounts for 0.25% to 1% of total U.S. passenger enplanements
Small Airport Hub - accounts for 0.05% to 0.25% of total U.S passenger enplanements
Non – Hub - accounts for 2,500 enplanements to 0.05% of total U.S. passenger enplanements

Source: Oliver Wyman

Table C.2. Index of deplaning load factors (Seat Factors) by time of day.

Index of Deplaning Load Factors (Seat Factors) by Time of Day

Hour	Index of Arrival (Deplaning) Load Factors						
	Large Eastern	Large Central	Large Pacific	Medium Eastern	Medium Central	Small Eastern	Small Central
0000 -0059	0.982	1.048	0.917	1.008		1.012	
0100 -0159	0.987		0.928				
0200 -0259							
0300 -0359							
0400 -0459	1.168				1.169		
0500 -0559	1.103				1.059		
0600 -0659	1.003			1.182			
0700 -0759	0.902			0.593	0.946		
0800 -0859	0.949	0.772	0.723	0.832	0.843		
0900 -0959	0.926	0.888	0.919	0.853	0.829	0.771	1.006
1000 -1059	1.035	0.949	0.932	0.864	0.899	0.891	1.019
1100 -1159	0.985	0.879	1.078	1.005	0.942	0.951	0.805
1200 -1259	1.039	1.064	1.070	1.042	0.996	1.012	0.866
1300 -1359	1.030	1.018	1.066	1.010	1.086	1.059	1.050
1400 -1459	1.040	1.036	1.044	1.007	1.026	1.033	1.018
1500 -1559	1.039	1.077	0.983	1.026	1.039	1.101	1.086
1600 -1659	1.065	1.054	0.867	1.026	1.098	1.038	1.023
1700 -1759	1.018	0.957	1.062	1.081	1.079	0.998	1.158
1800 -1859	1.028	1.044	1.044	1.075	1.053	1.074	1.184
1900 -1959	1.004	1.017	1.025	1.003	0.961	1.028	
2000 -2059	0.958	1.026	1.054	1.036	1.041	1.027	
2100 -2159	0.884	1.023	1.025	0.986	0.985	0.984	0.973
2200 -2259	0.921	1.080	0.888	0.974	1.028	0.994	1.014
2300 -2359	1.015	0.996	0.972	1.104	1.019	0.980	

Notes: Sample includes data from airlines accounting for 20 to 30 percent of national enplanements and includes 59 airports.

Large Airport Hub - accounts for 1% or more of total U.S. passenger enplanements
Medium Airport Hub - accounts for 0.25% to 1% of total U.S. passenger enplanements
Small Airport Hub - accounts for 0.05% to 0.25% of total U.S. passenger enplanements
Non – Hub - accounts for 2,500 enplanements to 0.05% of total U.S. passenger enplanements

Source: Oliver Wyman

Table C.3. Index of enplaning load factors (Seat Factors) by time of day.

Index of Enplaning Load Factors (Seat Factors) by Time of Day

	Index of Departure (Enplaning) Load Factors						
Hour	Large Eastern	Large Central	Large Pacific	Medium Eastern	Medium Central	Small Eastern	Small Central
0000 -0059							
0100 -0159							
0200 -0259							
0300 -0359							
0400 -0459							
0500 -0559	0.850	0.983		1.033	0.774	1.093	1.009
0600 -0659	0.919	1.052	0.913	1.023	0.965	1.032	0.991
0700 -0759	0.922	1.053	0.999	1.028	0.995	1.065	0.944
0800 -0859	0.919	1.064	1.018	1.016	1.073		1.083
0900 -0959	1.004	1.038	0.872	1.131	0.999	1.340	1.052
1000 -1059	0.992	1.035	1.094	1.063	1.031	1.120	1.114
1100 -1159	1.049	0.958	1.048	0.978	1.047	1.163	1.076
1200 -1259	0.982	1.084	1.045	1.127	1.083	0.994	1.066
1300 -1359	1.023	1.002	1.003	1.020	1.085	1.116	1.077
1400 -1459	1.032	0.857	1.014	1.009	1.090	0.892	1.004
1500 -1559	1.028	1.068	0.958	0.993	0.981	1.053	0.967
1600 -1659	1.042	0.926	0.978	1.049	0.969	0.820	0.962
1700 -1759	1.057	0.927	0.966	0.939	1.001	0.888	0.950
1800 -1859	1.042	0.908	0.785	0.900	0.960	0.878	0.901
1900 -1959	0.983		0.851	0.814	0.880		0.849
2000 -2059	0.941			0.648	0.762		0.639
2100 -2159	0.963		1.019		0.697		
2200 -2259	1.004		1.071				
2300 -2359	0.934		1.004				

Notes: Sample includes data from airlines accounting for 20 to 30 percent of national enplanements and includes 59 airports.

Large Airport Hub - accounts for 1% or more of total U.S. passenger enplanements
Medium Airport Hub - accounts for 0.25% to 1% of total U.S. passenger enplanements
Small Airport Hub - accounts for 0.05% to 0.25% of total U.S. passenger enplanements
Non – Hub - accounts for 2,500 enplanements to 0.05% of total U.S. passenger enplanements

Source: Oliver Wyman

APPENDIX D

Suggested Peak Period Definitions by Facility Type

Facility	Appropriate Peak Period (minutes)			
	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: ACRP 03-12 Peak Period and Operational Profile Questionnaire.

APPENDIX E

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 60 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 United States. 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): Publicly 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 which 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 United States 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 agreement 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.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation