Guidebook on General Aviation Facility Planning

DETAILS

138 pages | 8.5 x 11 | PAPERBACK
ISBN 978-0-309-28406-6 | DOI 10.17226/22300

AUTHORS

Douglas E. Sander, Robert B. Chapman, Stephanie A.D. Ward, Summer Marr, and Sarah Arnold; Airport Cooperative Research Program; Transportation Research Board; National Academies of Sciences, Engineering, and Medicine

AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 113

Guidebook on General Aviation Facility Planning

Douglas E. Sander and Robert B. Chapman
DELTA AIRPORT CONSULTANTS, INC.
Raleigh, NC, and Atlanta, GA

Stephanie A.D. Ward
MEAD & HUNT, INC.
Lansing, MI

Summer Marr and Sarah Arnold
MARR ARNOLD PLANNING, LLC
Ames, IA, and Cincinnati, OH

Subscriber Categories
Aviation • Planning and Forecasting

Research sponsored by the Federal Aviation Administration

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2014
www.TRB.org

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.

ACRP REPORT 113

Project 07-10
ISSN 1935-9802
ISBN 978-0-309-28406-6
Library of Congress Control Number 2014940548

COPYRIGHT INFORMATION

NOTICE

The project that is the subject of this report was a part of the Airport Cooperative Research Program, conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council.

The members of the technical panel selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical panel and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

The opinions and conclusions expressed or implied in this report are those of the researchers who performed the research and are not necessarily those of the Transportation Research Board, the National Research Council, or the program sponsors.

The Transportation Research Board of the National Academies, the National Research Council, and the sponsors of the Airport Cooperative Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of the report.

Published reports of the

AIRPORT COOPERATIVE RESEARCH PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

and can be ordered through the Internet at

http://www.national-academies.org/trb/bookstore

Printed in the United States of America

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. C. D. Mote, Jr., is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Victor J. Dzau is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. C. D. Mote, Jr., are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is one of six major divisions of the National Research Council. The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

www.national-academies.org

C O O P E R A T I V E   R E S E A R C H   P R O G R A M S

CRP STAFF FOR ACRP REPORT 113

Christopher W. Jenks, *Director, Cooperative Research Programs*
Michael R. Salamone, *ACRP Manager*
Joseph D. Navarrete, *Senior Program Officer*
Terri Baker, *Senior Program Assistant*
Eileen P. Delaney, *Director of Publications*
Hilary Freer, *Senior Editor*

ACRP PROJECT 07-10 PANEL
Field of Design

Kenneth L. Penney, Jr., *KLJ, Rapid City, SD* (Chair)
Michael S. Hines, *Metropolitan Washington Airports Authority, Washington, DC*
Richard T. Lanman, *Auburn-Lewiston Municipal Airport, Auburn, ME*
David B. Lucas, *AV Ports, Quonset State Airport, North Kingstown, RI*
Thomas F. Mahoney, *Massachusetts DOT, East Boston, MA*
Sara D. McCook, *United Airlines, Denver, CO*
Douglas R. Anderson, *FAA Liaison*
Bill Dunn, *Aircraft Owners and Pilots Association Liaison*
Christine Gerencher, *TRB Liaison*

FOREWORD

By Joseph D. Navarrete
Staff Officer
Transportation Research Board

ACRP Report 113: Guidebook on General Aviation Facility Planning (the Guidebook) provides practical guidance for planning airport facilities designed to accommodate general aviation (GA) aircraft. Airport practitioners will find the Guidebook helpful for translating anticipated GA activity into facility requirements and layouts. Although the Guidebook is geared to airport industry practitioners, the lay reader will also benefit from the sections that provide background on GA aircraft and activities and the unique facility needs of this segment of the industry.

General aviation (GA) is the largest category of aviation and consists of all activity not considered to be commercial service or military. GA operations occur at airports of all sizes and types, including commercial service airports, GA airports, and military joint-use facilities. The GA fleet is varied, ranging from single-engine aircraft to large business jets and helicopters; in addition, there is a broad range of GA activity, including flight training, recreation, business, and agriculture. Yet current guidance for GA facility planning is limited and does not reflect the changes occurring in the industry. Research was needed to provide comprehensive guidance to help airport practitioners plan GA facilities that are responsive to industry needs, flexible, and cost-effective.

The research, led by Delta Airport Consultants, included a review of FAA Advisory Circulars and Orders, as well as other relevant literature. This was followed by industry outreach to understand current GA planning practice and needs. The research team visited numerous airports and interviewed many stakeholders, including airport management, operations/maintenance staff, consultants, and service providers. This research, combined with the contractor's expertise, was used to develop the Guidebook.

Chapter 1 provides background and suggestions for using the Guidebook. A description of GA activity is provided in Chapter 2. The benefits of airport planning and its relevance to airport operations and long-term development are described in Chapter 3. Chapter 4 provides a framework for GA facility planning—discussing governing documents, grant assurances, financing, GA services, and the activity indicators that drive facility planning. Chapter 5 addresses planning for specific facilities, including terminals and fixed-base operator buildings, auto parking, aircraft parking aprons, hangars, fuel farms, wash racks, helicopter parking, and other facilities. A key feature of this guidance is adjacency considerations (i.e., how various facilities should be located relative to each other based on function). The appendices consist of a list of abbreviations and terms, a discussion on how to size a parking area, a process for estimating the number of aircraft parking positions, and a bibliography of planning resources.

CONTENTS

CHAPTER 1

Introduction

Well-planned GA facilities are often the key to a financially healthy airport. Good GA facilities are critical to an airport's ability to meet user needs and are a significant revenue source for GA and commercial service airports. *ACRP Report 113: Guidebook on General Aviation Facility Planning* (the Guidebook) recommends a planning process for GA facilities, addresses many considerations that go into such planning, and provides economical and efficient layouts for each facility. The Guidebook is intended to be useful for all airports, regardless of type, size, or activity level.

The types of GA facilities covered by this Guidebook include

- Aprons and tie-downs
- Hangars
- Terminal buildings
- Fixed-base operations
- Administration buildings
- Maintenance storage
- Fueling facilities
- Aircraft wash facilities
- Security
- Ground access and auto parking
- Helicopter parking

Purpose

This Guidebook has been developed to help airport owners, planners, engineers, local/state/federal aviation officials, and airport business tenants [e.g., fixed-base operators (FBOs)] better plan and develop facilities to meet the needs of an airport's GA users. Specific purposes of the Guidebook are to

- Provide an overview of general aviation and airport planning
- Suggest a planning processes for GA facilities
- Provide guidance on what information to consider when determining facility requirements
- Identify and provide guidance for factoring in the many considerations and principles that govern a good plan
- Help Guidebook users develop efficient and cost-effective GA facility layouts
- Provide examples of facility layouts for various activity levels

Properly planned terminal area facilities need to reflect consideration of the airfield infrastructure (e.g., the location, length, and width of runways and taxiways). Good planning needs to consider established airport geometric standards for where buildings and parked aircraft should and should not be located relative to the airfield (runways and taxiways). Although suggestions in this Guidebook will reflect those geometric standards, specific standards for runways and taxiways are covered by FAA Advisory Circular, 150/5300-13A, *Airport Design*. This Guidebook focuses on the planning of the GA facilities themselves.

Organization

This Guidebook's organization flows from a high-level view of GA and GA facilities to a broad discussion about airport and GA facility planning and then to very specific guidance for each facility type (see Exhibit 1-1). Early chapters introduce what general aviation (Chapter 2) and airport planning (Chapter 3) are. The Guidebook then transitions to GA facility planning (Chapter 4) and sizing and layout guidance for each type of facility (Chapter 5). The Guidebook appendices contain a resource listing, terms and abbreviations related to GA facility planning, guidance on tie-down parking areas, and guidance on how to determine the number of aircraft parking positions needed. Items included within each chapter are presented in Exhibit 1-2.

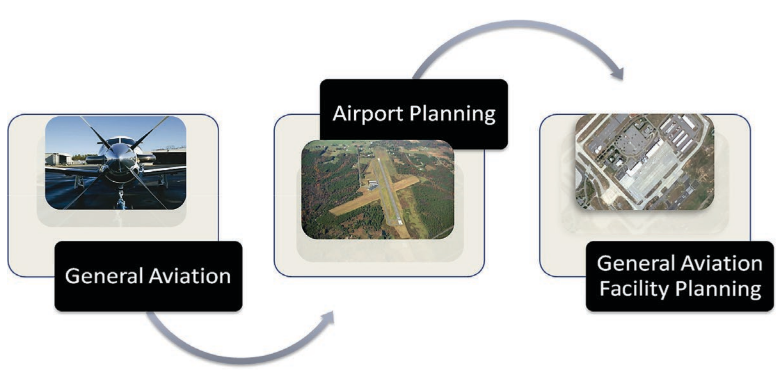
Using the Guidebook

Each airport is unique. Therefore, this Guidebook is not a one-size-fits-all prescription for planning. The planning considerations that go into a new basic GA airport and its layout/sizing of facilities are much different than the considerations that go into the planning of facilities at a complex GA reliever or air carrier airport with considerable existing infrastructure, different business models, or little opportunity to expand facilities. Although the Guidebook cannot address the unique needs of each airport, it will help the user better understand basic planning principles, learn about typical planning processes, learn considerations that go into the layout of facilities, and consider generic examples of facility layouts as appropriate.

The intended audiences and how they may use this Guidebook are as follows:

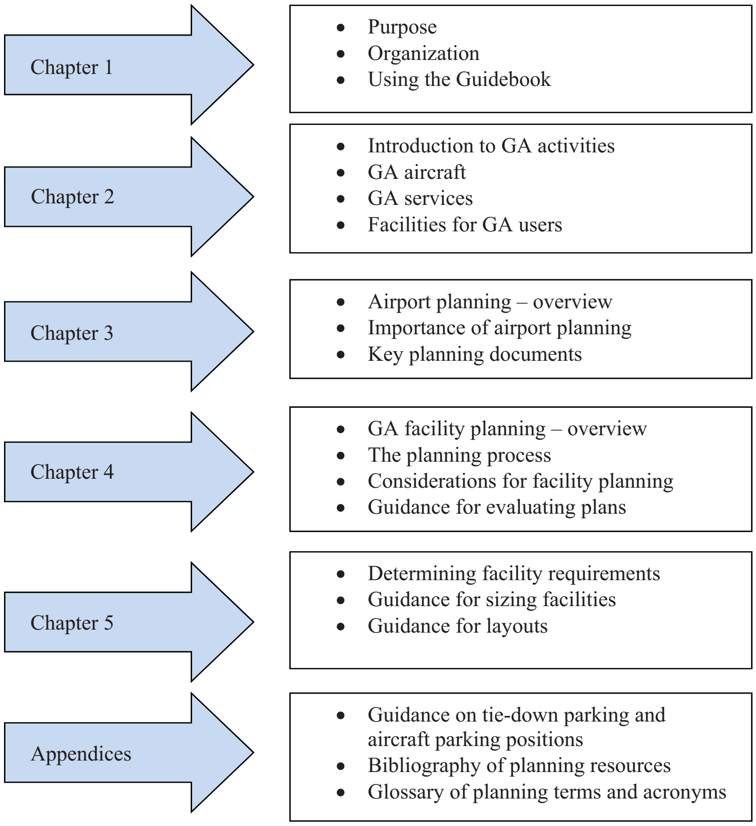
- **Airport owners and policymakers,** such as board members, elected officials, economic development staff, and community leaders who need a good understanding of general aviation, GA airport services, and facilities that provide those services. This will in turn help them plan budgets, adopt community visions, recognize funding opportunities, and understand the airport planning process. **This audience will primarily benefit from Chapters 2 and 3.**

Exhibit 1-1. Overview of Guidebook.



Source: Delta Airport Consultants, Inc.; Google Earth, Digital Globe

Exhibit 1-2. Guidebook content.



- **Airport management and staff** are generally interested in developing the overall airport plan and specific GA facility plan. Usually they focus on identifying facility requirements, establishing a good plan, and the sizing and layout of facilities. **This audience will primarily benefit from Chapters 4 and 5.**
- **Airport planners/consultants** are very familiar with general aviation, the need for certain facilities, and the principles that make up a solid plan. **This audience will primarily benefit from Chapters 4 and 5.**
- **Airport tenants**, such as FBOs, lease areas or facilities provided by the airport, but some do develop their own facilities or participate in the airport owner's planning process. **This audience will benefit from Chapters 4 and 5.**
- **Local/state/federal agencies** will benefit from all chapters, depending on their staff's role in planning.

This Guidebook supplements other available guidance such as FAA Advisory Circulars, Orders, State Aviation System Plans, and other state aviation planning guidelines. These and other documents that govern or help with GA facility planning are summarized in Chapter 4. Guidebook users need to be aware of these resources and how they may be useful.

CHAPTER 2

General Aviation—Overview

To plan for GA facilities at airports, it is important to have a basic understanding of what GA is and the various factors that need to be accounted for when planning long term for these types of operations. Put simply, GA consists of all operations not considered commercial service (i.e., airlines) or military. GA operations can occur at airports of all sizes and types, including commercial service airports, GA airports, and military joint-use airports. Per the FAA, three out of every four takeoffs and landings in the United States are conducted by GA aircraft. Therefore, sound planning of GA facilities is critical to the continued operation of the national aviation system.

Many factors affect GA facility planning, including

- The type of GA activity
- Aircraft types
- Airport classifications
- Facility and service needs/requirements

These factors are discussed in greater detail in the following sections.

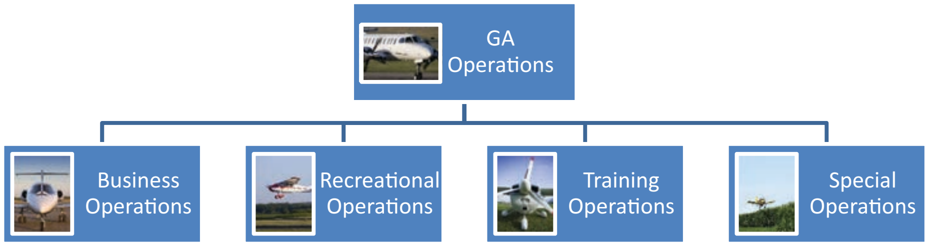
This chapter presents the types of GA operations and activities that may take place at an airport, the types of GA aircraft and their impact on facility requirements, and the classification of airports that support GA at the federal level.

GA Operation Types

GA operations are considered to be those aircraft operations not conducted by a commercial airline or the military. Various activities are included under GA operations, as shown in Exhibit 2-1. Each type is discussed on the following pages—this is not an extensive categorization of GA operations, but a general organization of operations into a few main types:

- **Business Operations:** Many businesses use GA aircraft to transport both goods and people. These companies understand the value of general aviation and the time savings that it can offer in comparison to commercial service aviation or ground transportation. With on-demand access, no security screening, and the ability to fly virtually anywhere (usually point-to-point), travel time becomes a fraction of what it would be otherwise. Companies and staff appreciate the time and cost savings that result. Business-related operations are often conducted using corporate aircraft and pilots, although many operations are conducted through aircraft charter services that offer aircraft and pilots for hire.
- **Recreational Operations:** Many GA operations are considered recreational (e.g., when pilots use aircraft for flights associated with tourism, airplane rides at air shows, and general transportation between locations that is not for hire).

Exhibit 2-1. Types of GA operations.



Source: www.istockphoto.com

- **Training Operations:** Flight training operations, whether for personal pleasure or for career development, can be classified in this category. Flight training operations may be associated with a well-established flight program (e.g., Western Michigan University, University of North Dakota, and Embry-Riddle Aeronautical University) where students are often training to become commercial airline pilots. Other training operations may be associated with a one or two-person managed local flight school, where students are learning how to fly for fun. Training operations make up many aircraft operations at airports throughout the country.
- **Special Operations:** Operations considered special include, but are not limited to, those conducted for research, surveillance, agricultural spraying, emergency response, remote access, fire suppression, and law enforcement. Numerous entities (e.g., federal and state agencies, universities, and hospitals) rely on GA to carry out their missions.

GA Aircraft Types

GA operations are conducted using various aircraft—from large corporate jets to small, single-engine aircraft. This wide variation in aircraft types can make planning efforts for GA facilities challenging because the needs of smaller aircraft differ from those of larger aircraft. Examples of GA aircraft are provided in Exhibit 2-2.

In addition to typical aircraft types, specialized aircraft are often used for GA operations. See Exhibit 2-3 for examples of specialized aircraft such as crop spraying planes, amphibious planes (those that can operate on land and on water), unmanned aerial vehicles (UAVs) such as drones, and aircraft used for fire suppression.

The types of aircraft operating at an airport affect its facility and service needs and requirements. The FAA, through Advisory Circular (AC) 150/5300-13A *Airport Design*, has established specific design criteria based on what aircraft is considered to be the critical aircraft or *design aircraft*. This aircraft is defined as the most demanding aircraft (or group of aircraft) that makes at least 500 annual operations at an airport. The design aircraft is defined using two coding systems established by the FAA—the Aircraft Approach Category (AAC) and the Airplane Design Group (ADG):

- **Aircraft Approach Category (AAC)** is designated by a letter (A-E). This component relates to the operational characteristic of aircraft approach speed, with "A" being the slowest and "E" being the fastest.
- **Airplane Design Group (ADG)** is designated by a Roman numeral (I-VI), related to the physical characteristics of airplane wingspan or tail height, with "I" being the smallest and "VI" being the largest.

Together, the AAC and the ADG of the design aircraft make up the Airport Reference Code (ARC) of an airport. The ARC signifies the airport's highest Runway Design Code (RDC) and

Exhibit 2-2. Examples of typical aircraft types.

Large Business Jet

Source: www.istockphoto.com

Single-engine Piston Aircraft

Source: www.istockphoto.com

Twin-engine Piston Aircraft

Source: www.istockphoto.com

Medium-sized Business Jet

Source: www.istockphoto.com

Exhibit 2-3. Examples of specialized aircraft.

Crop Sprayer

Source: www.istockphoto.com

Unmanned Aerial Vehicle

Source: www.istockphoto.com

Amphibious Aircraft

Source: www.istockphoto.com

Fire Suppression Aircraft

Source: www.istockphoto.com

Exhibit 2-4. FAA Airport Reference Codes.

FAA AIRPORT REFERENCE CODES

Aircraft Approach Category

Category A:	Speed less than 91 knots
Category B:	Speed 91 knots or more but less than 121 knots.
Category C:	Speed 121 knots or more but less than 141 knots.
Category D:	Speed 141 knots or more but less than 166 knots.
Category E:	Aircraft approach speed 166 knots or more.

Airplane Design Group

Group I:	Wingspan up to but not including 49 feet.
Group II:	Wingspan 49 feet up to but not including 79 feet.
Group III:	Wingspan 79 feet up to but not including 118 feet.
Group IV:	Wingspan 118 feet up to but not including 171 feet.
Group V:	Wingspan 171 feet up to but not including 214 feet.
Group VI:	Wingspan greater than 214 feet.

Source: FAA AC 150/5300-13A, *Airport Design*

is used for planning and design of the airport's facilities. Exhibit 2-4 outlines the components of the ARC.

The ARC corresponds to a specific set of design criteria that regulate the size and strength of pavements, separation requirements, safety areas, and more. Airports that serve commercial airline traffic and/or larger GA jet aircraft are likely to have a higher ARC than those that serve smaller single- and multi-engine GA aircraft.

Although airport runways and taxiways are generally planned based on the ARC, specific facilities (e.g., aprons and hangars) may be planned and designed based on the actual aircraft to use them. For example, an airport may serve large corporate jets, where runways and aprons may be designed for these larger aircraft; however, the airport will typically plan hangars for smaller single-engine piston aircraft, given that those are usually the based aircraft. If larger aircraft are planned for at the airport, they are usually concentrated in an area where the larger design standards can be met.

Airport Types

GA activities occur at both commercial service and GA airports, with planning at multiple levels, including local, state, and federal. An important component of airport planning includes classifying airports into different categories or types. This effort provides organization and a foundation for long-term planning. Although the classification of airports happens at multiple levels, this Guidebook focuses on the federal classifications only. States and local municipal bodies often have alternate classification criteria/definitions which may differ by location; therefore, discussing GA facilities from the federal classification system provides a common platform for the facility needs discussion in this Guidebook.

There are two sets of airport classifications at the federal level: one for the FAA's National Plan of Integrated Airport Systems (NPIAS) which includes both commercial service and GA airports, and another for GA airports specifically as a part of the FAA's *General Aviation Airports: A National Asset Study* (ASSET). The NPIAS has been in place since the 1940s in accordance with

Section 47103 of Title 49 of the United States Code. This program identifies airports significant to the national air transportation system and therefore eligible to receive funding grants for planning and development under the FAA's Airport Improvement Program (AIP). The NPIAS encompassed 3,355 airports as of the year 2013, including both commercial service airports and GA airports. Classifications of airports within the NPIAS are indicated in Exhibit 2-5. Of the airports classified in the NPIAS, 2,831 are GA (including reliever airports). This number changes as the system expands or contracts.

For an airport to be included in the NPIAS, it has to meet several basic criteria including

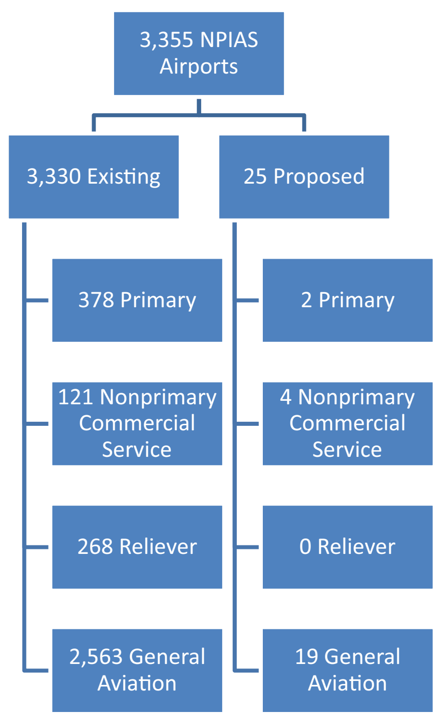
- Having at least ten based aircraft
- Being at least 20 miles from the nearest NPIAS airport
- Being included in a state system plan
- Having a willing local sponsor that is a public entity

The federal airport classification system/study (ASSET) looks at the roles of GA airports in the NPIAS exclusively and categorizes them into one of four types. This report helps structure the long-term planning of GA facilities, especially for state transportation departments that have incorporated the newly defined airport types/roles into their own state classification systems.

The ASSET study establishes four classifications of GA airports which are for all airports other than those considered to be primary airports. These classifications are as follows:

- **National**—"Supports the national and state system by providing communities with access to national and international markets in multiple states and throughout the United States."
- **Regional**—"Supports regional economies by connecting communities to statewide and interstate markets."

Exhibit 2-5. NPIAS airports.



Source: Report to Congress – National Plan of Integrated Airport Systems (NPIAS) 2013-2017

Exhibit 2-6. Types of airports.

National	Regional	Local	Basic
• 5,000+ instrument operations, 11+ based jets, 20+ international flights, or 500+ interstate departures; or • 10,000+ enplanements and at least one charter enplanement by a large certificated air carrier, or • 500+ million pounds of landed cargo weight	• Metropolitan Statistical Area (Metro or Micro) and 10+ domestic flights over 500 miles, 1,000+ instrument operations, 1+ based jet, or 100+ based aircraft; or • The airport is in a metropolitan or micropolitan statistical area, and the airport meets the definition of commercial service	• 10+ instrument operations and 15+ based aircraft; or • 2,500+ passenger enplanements	• 10+ based aircraft; or • 4+ based helicopters; or • The airport is 30+ miles from the nearest NPIAS airport; or • The airport is identified and used by the U.S. Forest Service, or U.S. Marshals, or U.S. Customs and Border Protection (designated, international, or landing rights), or U.S. Postal Service (air stops), or has Essential Air Service; or • The airport is a new or replacement facility activated after January 1, 2001 or • Publicly owned or privately owned and designated as a reliever with a minimum of 90 based aircraft

Source: *FAA General Aviation Airports: A National Asset, 2012.*

- **Local**—“Supplements local communities by providing access primarily to intrastate and some interstate markets.”
- **Basic**—“Supports GA activities such as emergency service, charter or critical passenger service, cargo operations, flight training, and personal flying.”

Each classification has different criteria that a GA airport must meet to be included. Exhibit 2-6 presents s the criteria for each classification.

In terms of planning for GA facilities, these criteria are often referenced when determining the level of use and types of users that an airport either serves or is anticipated to serve. These criteria can be a good indicator of the types of infrastructure that may be warranted or needed at a GA facility. Exhibit 2-7 illustrates sample airports for each of the four ASSET categories. Although the classification criteria do not include any infrastructure-based requirements, noticeable differences between basic, local, regional, and national airports can be seen (e.g., the size of aprons and terminal facilities, number of hangars, and presence of support facilities).

GA facility and service requirements vary depending on the types of aircraft and the number of operations conducted at an airport. For example, smaller airports that serve mostly single-engine GA aircraft may have shorter runway length needs, smaller aircraft storage facilities, and limited services available. Larger airports that serve mostly commercial aircraft and/or GA corporate aircraft, including jets, may have longer runway length requirements, provide additional services (e.g., 24-hour staff, fueling, training, and maintenance), have increased size and quantity of aircraft storage facilities, and have more precise navigational aids. Specific FAA design requirements are determined by the critical aircraft operating at an airport. Specific services and infrastructure that may be needed and/or provided for GA users are discussed below.

GA Services and Facilities on an Airport

GA aircraft require a wide array of services and facilities, often depending on aircraft, climate, and frequency and type of operation. Some of these services and facilities are provided by the airport owner; some are provided by private entities such as FBOs depending on the operational model used by an airport owner. In some instances, specialized aviation service operators

Exhibit 2-7. Sample ASSET category airports.

Source: *FAA General Aviation Airports: A National Asset, 2012.*

(SASOs) can provide these services as well. An FBO is a service provider that offers a multitude of activities at an airport (e.g., fueling, parking, storage, maintenance, rental, and flight training). Usually, an FBO must perform more than one of these sorts of activities to be considered an FBO. If a service provider only has a single activity, they are usually considered a SASO and they typically offer a specialized aeronautical service (e.g., aircraft sales, flight training, and aircraft maintenance or avionics services).

Aircraft Services

Providing amenities and services allows airports to serve a wide user base and multiple types of GA operations. The provision of these services should be appropriate to the airport size and the types and number of operations it supports. Each airport owner must assess the specific needs of its individual location. No two airports are alike and, therefore, require individual planning to meet site-specific needs.

Aircraft Parking

Aircraft parking is typically provided through an FBO or the airport staff. This service is important for aircraft based at an airport, as well as any itinerant aircraft not based at an airport but traveling to the area. Adequate area to accommodate the predominant size and number of aircraft that frequent the apron area for parking is necessary. Area for maneuvering aircraft must also be considered when planning for the aircraft parking area. A detriment for aircraft parked on an apron is that they are exposed to weather and other environmental factors, whereas aircraft parked inside a hangar are protected from these impacts. A fee is usually assessed for parking service and is often charged in one of two methods. A *landing fee* may be charged when an aircraft lands at an airport but does not necessarily park or stay for an extended period of time. A *tie-down* or parking fee is assessed where an aircraft is charged for parking on the apron or ramp area for a period of time. The length of time can vary, as well as the fee, based on individual airport policies.

Aircraft Storage

Aircraft storage can take many forms and includes enclosed structures such as hangars that provide protection from weather and other environmental factors (e.g., wildlife and debris). Often, aircraft owners want covered storage for their aircraft to preserve the condition of their investment and to reduce repair and maintenance costs. Aircraft storage needs vary from one airport to another based on the types and sizes of based aircraft and airport user needs. The need for aircraft security also influences the type of storage that an airport provides.

Airports have many methods to provide aircraft storage (e.g., airport owner leases of aircraft storage space, private owners subletting hangar facilities on leased airport-owned property, and single-owner private developments). Airports have to evaluate the revenue available to provide airport-owned aircraft storage versus leasing airport property for private development. Sound lease agreements ensure adequate maintenance of privately owned facilities.

Fueling Services

The provision of fueling services at an airport is critical for attracting and maintaining a based user group and for attracting itinerant aircraft to an airport. Similar to aircraft parking, this service is often performed by the staff of an FBO, but can be provided by airport staff if the airport has its own fuel facilities. Two fuel types are typically offered—100 low lead (LL) and Jet A. Their costs fluctuate based on the market, the same way that automobile gasoline prices fluctuate. With continued improvements in technology, such as the installation of credit card readers, many airports now offer 24/7 self-fueling options which has made providing fueling easier and more efficient.

Aircraft Maintenance

Aircraft maintenance and repair services are vital to keep aircraft airworthy for operation. Whether it be a minor repair or a major overhaul of aircraft engines, maintenance and repair services at airports support the continued operation of aircraft. Providing aircraft maintenance can be an attractant for aircraft, because pilots often like to be based at an airport where they know they can be afforded maintenance services should they need them. These services are usually provided by an FBO or a SASO that establishes a business at an airport to provide them.

Aircraft Rental

The availability of rental aircraft at airports supports pilots who do not own their own aircraft, as well as students who are learning to become pilots. Given that aircraft are costly to purchase, the option of renting aircraft provides an alternative for pilots to access the air transportation system without having to own their own aircraft. Furthermore, students in flight school need to have access to rental aircraft for training. In most instances, rental aircraft are provided by an FBO or a SASO for either rental purposes or as part of a flight training operation. Rates, types of aircraft, and rental policies vary greatly by location and need to be assessed on a site-by-site basis.

Flight Services

Similar to the discussion of rental aircraft, flight services are most often provided by an FBO or SASO and vary depending on the specific aircraft and demand demonstrated within a specific community. While one community may only be able to offer limited training opportunities, another may offer a robust training operation as well as charter activities with a wide range of aircraft.

Training. Offering flight instruction at airports often contributes to the growth of the aviation community by educating the next generation of pilots, both recreational and professional. Flight instruction, if available, is typically based at an airport or available on an on-call basis.

Charter. Charter service is often used by businesses and individuals who need an efficient method of air transportation without using commercial service. The availability of charter service provides on-demand service for passengers and cargo.

Aircraft Washing

Aircraft washing at an airport is typically the responsibility of the aircraft owner and most often is completed using a high-pressure hose near an apron. Aircraft wash racks for GA aircraft may be available for use at larger airports that serve a more robust user base; however, such racks are fairly uncommon because they can be costly to develop. An important concern for aircraft washing is local and state regulations that may be in place for treating the water runoff generated by the washing activities. For example, the use of detergents or cleaning agents harmful to the environment may need to be contained and, therefore, require defined locations for use or containment facilities.

Ground Services

Ground services include activities often focused on the pilot and passenger experience (e.g., flight planning activities, ground transportation, and catering/vending).

Waiting Areas

When passengers and pilots arrive from flights or prepare for departure, they often need waiting areas and restrooms. Such areas can also serve those waiting to pick up or drop off passengers. These areas can range from small one- or two-chair areas with minimal amenities to larger areas with couches, televisions, and workstations. Again, each airport must assess the needs of its users to determine what is most appropriate to offer.

Ground Transportation

Often the final destination for passengers is not the airport itself; therefore, providing vehicular transportation services is critical for users to reach their destinations. Ground transportation can be provided through methods such as a rental car service, the availability of a courtesy car which can be used temporarily, and even local mass transit (e.g., bus services or dial-a-ride services). Individual airport owners as well as FBOs often have to assess the level of demand and the benefits of providing these services compared to their cost and liability.

Vending/Catering

Much like a train station or a bus depot, when passengers enter or exit an aircraft from a trip to or from the airport, they often want access to food or beverages. Many airports accommodate this demand by having vending machines to dispense canned beverages and packaged snacks. At airports with frequent corporate or charter activities, there may be a demand to have established catering services or even a restaurant to meet food and beverage needs.

Pilot Services

The needs of a pilot extend beyond the physical needs of the aircraft and usually require spaces within the terminal/administration building and/or FBO facility. These needs often include a lounge area where pilots can be separated from the general public areas of the building so they can rest and relax in between flights. This is usually a very important element at airports where corporate pilots are frequently waiting for passengers for an extended period of time. Also, there is usually a need for flight planning facilities, where pilots have access to a computer than can be used to obtain weather briefings and to file flight plans prior to departure.

Airport Operations Services

Operating an airport requires certain activities related to keeping the airport open and well maintained. These activities require the use and storage of equipment.

Grass Mowing

Given that most airports have large expanses of areas covered by vegetation, mowing equipment is usually needed. Such equipment requires dedicated storage areas for the mowers and tractors. This is only relevant to those airport owners or FBOs who may handle these duties—some airports contract such services to private vendors or have other municipal departments that can accomplish these tasks. In these instances, there may be no need for storage facilities. Some airports lease grassy areas to local farmers who benefit from the grass crop while the airport receives free mowing and maybe some revenue.

Snow Removal

Airports in colder climates need to address snow removal to keep runways open during winter months. Typical winter weather in many states can produce varying amounts of snow; therefore, snow removal is important for the safe operation of both local and itinerant flights. Snow removal is achieved by using snow removal equipment (SRE) such as plows, brooms, and blowers. Snow removal can be accomplished in various ways—by airport owners, FBOs, or private vendors. How snow is removed will determine if an airport needs to have dedicated facilities and equipment to accomplish it. This should be kept in mind when evaluating facility needs for SRE. Also, finding places in a busy constrained terminal area for storage and disposal of plowed snow needs to be considered when planning such GA facilities.

Aircraft Rescue and Fire Fighting (ARFF)

Although ARFF services are not required at non-certificated airports, some GA airports may choose to have ARFF services because they find it advantageous. For aircraft operators, the presence of ARFF services may reduce insurance rates; for the airport, the presence of ARFF facilities increases the safety margin of the airport. ARFF services can often be expensive for a GA airport, given the cost for the equipment and staffing and related training. ARFF should be positioned with access to the airfield.

GA Facilities

A wide array of infrastructure may be needed or required at an airport supporting GA operations. Although this Guidebook focuses on GA facilities, it is important to address general airfield infrastructure as well, so as to ensure a basic knowledge of the airfield and how it relates to GA facility planning. Chapter 4 provides more detail, including the relationship between GA facilities and airfield infrastructure. General airfield infrastructure (e.g., runways, taxiways, and navigational aids) are discussed in this section.

Runways

The FAA defines runways as rectangular surfaces on an airport prepared or suitable for the landing or takeoff of airplanes. Runway lengths and widths vary based on the performance criteria of the critical aircraft which use them, as well as the design criteria defined in FAA AC 150/5300-13A, *Airport Design.* Characteristics of runways can differ from one airport to the next, including the orientation and type of surface, along with the length and width of the surface. Criteria that should be considered when siting a runway include critical aircraft demand, wind coverage, and proximity to existing runways, taxiways, and built areas (e.g., hangar and terminal areas). Approach clearances to meet the instrument flight procedure minimums for the specific runway ends must also be assessed.

Airports that have more than one runway, especially if runways are oriented in different directions, are often said to have a *primary runway* and a *crosswind runway.* Usually the longer of the two runways is oriented to provide the maximum wind coverage at an airport and is considered to be the primary runway. The other runway, usually a shorter runway, if oriented to provide additional wind coverage from a direction other than that predominately served by the primary runway, is called the crosswind runway. Airports are not required to have multiple runways but often do. Where there are significant operations, an airport may even have *parallel runways* (i.e., two runways oriented in the same direction, offset by various widths based on FAA criteria to provide for additional operations).

Taxiways

The FAA defines taxiways as pavements established for the taxiing of aircraft from one part of an airport to another. Similar to runways, taxiways are also designed based on the ARC of the critical aircraft which uses an airport, along with design criteria set forth in FAA AC 150/5300-13A, *Airport Design*, which includes specific criteria defined by Taxiway Design Groups (TDGs). Taxiways are used by aircraft to enter and exit a runway, as well as to reach terminal or apron areas for parking, which minimizes the time that aircraft are on a runway.

Taxiways are developed at airports to support the needs of the airport users. A *full parallel taxiway* extends parallel to the entire length of the primary runway. Having this surface, with connectors to the runway so aircraft can enter/exit the runway quickly, minimizes the time an aircraft occupies a runway when preparing for takeoff or on landing, creating a safer operating environment. *Partial parallel taxiways* typically extend from a ramp or terminal area to one runway end. A third type of taxiway is a *connector taxiway* which typically provides direct access to a runway at an airport without a parallel taxiway. A fourth type of taxiway is *taxilanes* which are the secondary routes serving aircraft movement in and around hangars and tie-downs.

Aprons

Aprons or aircraft ramps are designated surfaces typically adjacent to terminal buildings, maintenance hangars, air cargo facilities, and aircraft hangars that provide areas for aircraft

Exhibit 2-8. Apron tie-downs.

Location: Sheboygan County Memorial Airport – Sheboygan Falls, WI
Source: Mead & Hunt, Inc.

parking, loading and unloading, fueling, and servicing. Apron areas typically vary in size and location based on

- The level and nature of demand;
- Type and size of aircraft intended to use the surface;
- Access, handling, and user requirements;
- FAA design standards; and
- Aircraft maneuvering needs.

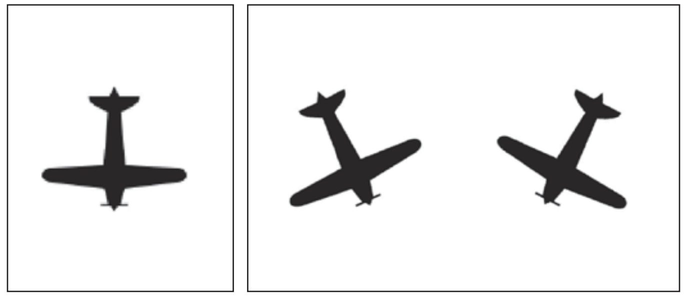
Exhibit 2-8 shows an apron area with multiple tie-down locations during a special event. Aprons that support a terminal building or an FBO facility may have more requirements than aprons dedicated to general hangars or tie-down area. Maneuvering areas and the designation of taxiways versus taxilanes through or around apron areas can affect the amount of area available for aircraft parking and should be considered when evaluating layouts and sizing. Chapters 4 and 5 discuss the planning of aircraft aprons in detail.

Hangars (Conventional and T-Hangars)

Two primary types of hangars are constructed at airports serving GA aircraft—conventional and t-hangars. Although these facilities have common elements, nuances need to be considered with each.

Conventional. Conventional hangars, commonly known as box hangars, have been given their name based on their square/rectangular shape. These hangars vary in size from large corporate style with plenty of square footage to store multiple larger jet aircraft, down to smaller hangars intended to store a single multi-engine or single-engine aircraft (shown in Exhibit 2-9). Such hangars are often designed to provide for both automobile parking and aircraft parking in addition to the building itself. The parking lot should generally be sized to accommodate the use planned for the hangar. For example, larger corporate box hangars can house corporate flight departments with a significant number of passengers who need to park their cars near the hangar, while smaller privately owned box hangars may be able to park a car inside the hangar while the aircraft is being flown. The amount of apron area or approach to the hangar can also vary based on several factors. The primary consideration is the access in front of the hangar. If a hangar is accessing a taxiway or taxilane/taxistreet that services other hangars, it is often a good

Exhibit 2-9. Conventional (box) hangar layouts.

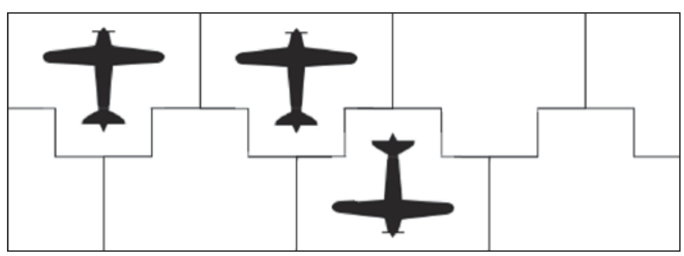


Source: Mead & Hunt, Inc.

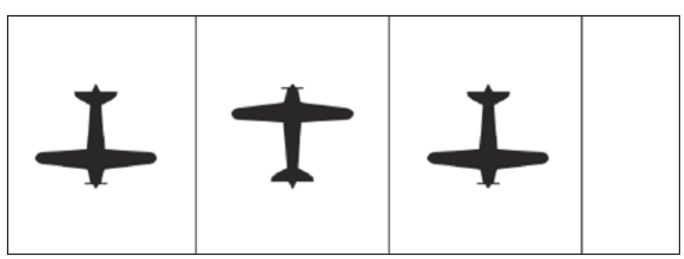
idea to plan for an apron in front of the hangar that would allow the anticipated aircraft to sit in front of the hangar, on the apron, without obstructing the taxi area. This allows the aircraft to have room to be fueled, tugged into the hangar, loaded, and so forth, in front of the hangar without blocking other aircraft using the taxiway/taxilane. If the hangar opens onto an apron area, these same sorts of considerations should be given to the areas for maneuvering aircraft as well as parked aircraft.

T-Hangar. A t-hangar is a rectangular shaped building split into numerous sections, often in the shape of a "T" that store multiple smaller aircraft. Typically, doors on both sides of the structure provide access for each owner/lessee to their aircraft and their section of the hangar. This type of hangar can vary in length, depending on how many units are inside (typically, five to ten units) and the size of each unit based on the wing span and associated door width provided. Such hangars are typically laid out so as to have multiple buildings in a single area so that the taxilanes that serve the buildings can be maximized with access to the taxilanes from both sides. Exhibit 2-10 illustrates two types of t-hangars—nested and block style. These hangars, like the conventional style, need to have approaches or aprons for access from the taxiway/taxilane. Consideration should be given as to the size of these areas to allow for ingress and egress by others

Exhibit 2-10. T-Hangar layouts.



Nested T-Hangar Layout



Block Style T-Hangar Layout

Source: Mead & Hunt, Inc.

when taxiing. In some instances, especially where snow removal is a consideration, airports often create a hard surface area from the face of one t-hangar to another to create a continuous hard surface that is easier to maintain than a layout where each unit has an individual approach to the hangar door with grass areas between the approaches. Such areas can complicate snow removal and increase mowing requirements between the paved areas. The eligibility of these additional paved areas should be discussed with the FAA prior to construction if using federal funds. Given that these types of hangars are often the home to smaller aircraft and many of the pilot automobiles are often stored inside the hangars when the aircraft are being flown, a small common-use automobile parking area may be appropriate.

Fueling Facilities

The availability of fuel is a major factor when aircraft owners decide where to base aircraft. It is also important to serve itinerant user fuel needs as well. Fueling facilities are commonly found at airports of all sizes, and typically include at least two fuel tanks (underground or aboveground) for 100 low lead (100LL) and Jet A fuels. Larger airports will likely have more than two tanks and may even have offsite fuel storage. Airports have various ways to dispense the fuel from these tanks. Some airports use fuel trucks, either parked on an apron area or in a hangar area, to transport the fuel to the aircraft. Often, fueling can take place at dedicated pump areas with an airport staff member or an FBO staff member pumping the fuel into the aircraft. Sometimes fuel can be pumped by the pilot through the use of a credit card reader for self-fueling. When these self-fueling options are available, they often provide 24/7 service that is attractive to pilots who may need access to the fuel services after normal business hours.

The siting of the fuel facilities should consider the apron area available for both parking and maneuvering to and from the fuel tank area. Siting decisions should also consider the access to the fuel area by the distribution trucks that need to drive near the tanks for filling purposes. The specific local and state regulations for fuel storage and containment also must be addressed.

Heliport and Helicopter Parking Pad

Heliports and helicopter parking pads are designed specifically for rotary aircraft operations. The design standards for heliports and associated infrastructure are included in FAA AC 150/5390-2C, *Heliport Design.* The size of the touchdown and liftoff area (TLOF) is based on the rotor diameter of the design helicopter and is square in shape. The design of a heliport has specific criteria that include ground-based standards as well as approach and departure areas. A helicopter parking pad is similar to an apron used for parking fixed-wing aircraft. The size of the apron depends on the number and size of specific helicopters to be accommodated. If the heliport or helipad is expected to serve emergency service or medical uses, it is important to plan access for vehicles such as ambulances between the airfield areas and the vehicular parking areas.

Airfield Lighting, Signage, and Navigational Aids

Lighting, signage, and navigational aids on an airport increase the utility of an airfield by increasing visibility and enhancing safety. Lighting is typically focused on the runway and taxiway surfaces and is usually paired with appropriate airfield signage. Navigational aid use can range from airport to airport, depending on the level of use and the types of aircraft instrument approaches.

Often, instead of leaving the lighting, signage, and navigational aids on for extended periods and drawing electricity, systems are controlled via radio transmission, usually called a *pilot-controlled lighting system.* Using the radios found inside the cockpit of an aircraft, the pilot-in-command can activate the lighting system when necessary. Many airports operate their lighting infrastructure with this type of system.

Runway Lighting. Runway lighting defines the edges of a runway surface during nighttime and low-visibility conditions and provides a visual cue to pilots of the runway distance remaining. Runway lighting is classified into three types based on illumination intensity:

- High-Intensity Runway Lighting (HIRL),
- Medium-Intensity Runway Lighting (MIRL), and
- Low-Intensity Runway Lighting (LIRL).

Taxiway Lighting. Similar to runway lighting, taxiway lighting outlines the edges of the taxiway surfaces to help pilots identify the locations of taxiways during times of reduced visibility and at nighttime. Taxiway lighting is classified in the same way as runway lighting—High-Intensity Taxiway Lighting (HITL), Medium-Intensity Taxiway Lighting (MITL), and Low-Intensity Taxiway Lighting (LITL).

Signage. Signage on the airfield is used to identify the location of

- Runway/runway intersections;
- Taxiway/taxiway intersections;
- Runway and taxiway designations;
- Runway ends;
- Hold lines; and
- Directional information to facilities such as terminals and FBOs.

As with the lighting, the specifics for the design and installation of signage features need to follow the FAA criteria as outlined in various FAA ACs. Signage location, number, and type are based on the type of runway and the associated instrument approaches present at an individual airport.

Navigational Aids. Navigational Aids (NAVAIDs) are ground-based equipment at an airport that helps pilots identify the location of an airport, the location of a runway threshold, and the proper slope of descent on approach for landing. NAVAID equipment includes lighting systems, radio transmitters, and visual devices.

Visual Guidance Slope Indicator (VGSI). A VGSI is a lighting system at the approach end of a runway that assists pilots in determining the correct glide path on approach for landing at an airport. VGSIs include a series of angled red and white colored lights that compose different lighting patterns to indicate the angle of approach for a pilot when locating the proper glide path. Visual Approach Slope Indicators (VASI) and Precision Approach Path Indicators (PAPI) are the most common VGSI systems. Even though a VGSI is a ground-based NAVAID usually close to the runway environment, there are height issues related to the clearance of the approach path that an aircraft will fly when using the VGSI that must be accounted for when planning, designing, and implementing this system.

Runway End Identifier Lights (REILs). REILs are a system of synchronized, high-intensity, flashing lights at the end of a runway end to provide a positive indication of the runway threshold for a pilot. These lights are especially helpful for pilots operating in times of decreased visibility or in urban environments with an abundance of additional lighting nearby. The installation of REILs can require additional land acquisition near the runway end where they are located because the strobe lights used in the REILs can create a visual impact to land uses near the runway end.

Rotating Beacons. Rotating beacons are lights that rotate 360 degrees and identify the location and type of airport. Airports open for civilian use have beacons that alternate one green flash followed by one white flash. Beacons at military airports flash green followed by two white flashes. Rotating beacons help pilots identify the location of an airport or airports when en route to a destination. Because beacons are normally the tallest feature on an airport, the siting of a beacon should take into account the allowable heights based on Federal Aviation Regulation (FAR) Part 77 Surfaces as well as possible impacts to surrounding off-airport land uses.

Approach Lighting Systems. Approach lighting systems contribute to airport utility by providing additional navigational guidance. These systems vary depending on the type of airport, the type of approach, and the type of equipment installed to support the approach. These systems typically require that additional areas be dedicated for safety areas around the lighting equipment.

Wind Indicators. Wind indicators are conical fabric tubes that indicate wind direction and intensity as they fill with air in windy conditions. This NAVAID is typically near runway ends because they provide pilots with important wind information used to make course adjustments, if needed, prior to landing or after takeoff. Often these wind indicators are lighted, which allows them to be used by pilots in times of reduced visibility or at nighttime.

Remote Communication Outlets (RCOs). RCOs are radio receiver equipment that allow pilots to contact Flight Service Stations (FSS) for weather and flight planning information. This communication equipment is especially useful for pilots in areas that experience radio interference from environmental conditions or other radio transmissions and for airports outside the normal radio range needed to make contact with an FSS.

Terminal and/or Administrative Building, Including FBO Buildings

Terminal buildings provide essential services for passengers and pilots, as well as a facility for the transfer of passengers and flight crews to and from the aircraft. Terminal facilities range in size based on several factors, most important being the type of airport users. Buildings can range from a small pilot room for flight planning and resting to a large multi-room building that provides services for multiple uses. A terminal building or administrative building often provides the first impression of a community to visitors so it is important for a terminal building to be welcoming and provide a positive experience for the visitor. Often, the terminal building is a multi-purpose structure that also houses the functions of the FBO, particularly in many smaller GA airport settings. Conversely, an FBO building can often serve as the terminal building. Access to public facilities 24/7 from both sides of the fence is desirable. Specific uses for a terminal building include

- Waiting areas
- Restrooms
- Pilot lounges (including showers and sleeping accommodations)
- Vending
- Pilot planning areas (including access to a computer for weather and flight planning)
- Conference rooms
- FBO areas
- Airport manager offices

If standalone FBO facilities are constructed, they often have facilities very similar to a terminal building (e.g., pilot areas where pilots can rest, eat, and prepare for their next flight). These areas may include couches, chairs, TVs, computers, printers, desks, and/or kitchen areas. In addition to providing amenities for pilots, FBOs may have maintenance departments housed in a separate building or hangar. The size and shape of these buildings vary from airport to airport and reflect various factors (e.g., size of airport, number of customers, number of staff, and type of aircraft serviced). If an FBO has a standalone structure, it may share an apron with an airport, or the FBO may have a separate apron for aircraft servicing, fueling, and parking. Each airport owner typically assesses individual needs, available infrastructure, and agreements with the FBOs to address the specific operational format if standalone facilities are constructed.

Airport Rescue and Firefighting

Airports with FAA Part 139 certification must have ARFF vehicles and a facility to house and protect these vehicles. All airports supporting commercial airline service must have FAA Part 139 certification, and thus ARFF vehicles and storage facilities. For airports that support only GA operations, Part 139 certification and resulting ARFF buildings or equipment on the airfield are less common because these can be costly. In such instances, GA airports may have agreements with local public safety entities (e.g., fire and police) to provide emergency response services, including ARFF and medical first responders. If an airport is considering staffing an ARFF facility, specific response requirements and design criteria for the building and equipment must be met. Many GA airports have some form of emergency equipment ranging from wall-mounted extinguishers to small foam/powder units in the back of a truck.

Automobile Parking and Landside Access

The number of automobile parking spaces at an airport will vary based on parking demand, airport services, and local planning and zoning requirements. Functions or activities that may increase parking demand include restaurants, rental car facilities, flight training, corporate use of an airport where staff may be parking for extended periods of time or may have multiple persons on a flight, and the number and scheduling of airport and FBO staff who may be parking in these lots. Some airport terminal buildings also accommodate non-airport community activities that need automobile parking. Other items that may be considered when evaluating parking needs include

- Handicapped accessibility
- Lighting
- Pickup and dropoff points
- General circulation patterns
- Snow storage in cooler climates
- Possible landscaping needs in some communities based on local planning/zoning

Consideration should also be given to remote parking areas that may serve hangar complexes remote from the main terminal area. Providing small parking lots that can accommodate visitors who may not be familiar with the airport and its operation help reduce undesired automobile access to the airfield. Pilots meeting these visitors can escort them from these landside parking areas to the specific hangar area.

Landside access to the airport should consider how vehicles get to and from the terminal building and hangar facilities from the primary ground access. This usually includes an airport entrance road that brings automobiles to the terminal/administration area. Frequently, the hangar areas are then accessed from this central location. Some airports have multiple access points along the airport perimeter, usually created by development over a long period of time as demand warranted. Where possible, it is desirable to limit the amount of access that passenger vehicles have to the airside of an airport. This reduces the possibility of vehicle/aircraft incidents and increases safety.

Aircraft Wash Facility

An aircraft wash facility can vary in form from a dedicated hangar-like structure with high-pressure water jets designed specifically for washing aircraft to a high-pressure hose used to wash off an aircraft on an apron. Often, airports supporting only GA operations have no such facilities because they can be costly to develop and maintain; however, such airports often have dedicated areas where aircraft owners can wash aircraft with normal pressure hoses and the water is contained so as to address possible issues with detergents mixing with groundwater. Such dedicated areas are often found in larger hangar complex areas where a common water source is available.

Other Buildings (Maintenance, Snow Removal)

Additional buildings found at airports include facilities for storing SRE and for airport maintenance equipment (e.g., lawn mowers, tractors) and airport vehicles (e.g., pickup trucks or aircraft tugs). Although these buildings must have access to the airfield, valuable airside frontage for aviation-related uses must be maintained. Consequently, placing such buildings farther from the runway environment is recommended. Maintenance operations may be a component of an FBO—so in such situations, various pieces of equipment may be stored by an FBO within their facilities. If equipment is stored by the airport owner, equipment is usually found in a dedicated building or in a hangar that has not been used for aircraft storage. A dedicated facility is recommended so as to leave the hangar available for generating revenue. SRE storage may also be in the form of a hangar or may be a dedicated building for snow plows, blowers, sweepers, and trucks. Maintenance and SRE facilities should house the equipment and provide space for tools, supplies, and equipment needed to maintain these various pieces of equipment.

Security

Security infrastructure at an airport serving GA operations is often provided by fencing and access gates around an airfield. Security may also include cameras installed around the perimeter of an airport and at critical locations (e.g., gates, terminal buildings, hangar complexes, and parking lots). Typically a separate security facility is not found at airports supporting GA traffic only—instead security operations take place out of the main airport facility or terminal because security functions are usually provided by the airport staff/maintenance staff or FBO staff. Commercial service airports have Transportation Security Administration (TSA) presence along with additional security measures and facilities. In some instances, Customs and Border Protection (CBP) services may be at the airport and require space within the terminal or operational area. Specific needs for their operations should be considered if international inspections are desired at the airport.

Models for Providing Services and Facilities

There is a difference between aviation services and airport maintenance duties. The method of providing the various services, facilities, and maintenance duties necessary to operate a successful airport can vary greatly depending on the needs, interests, and financial considerations at an individual airport. Several methods can be used in their entirety, but most often are combined to create a hybrid solution for the individual airport needs. Three primary scenarios are most often found in the industry today:

- **Airport-owner-provided services:** In this scenario, the airport owner handles the staffing and provision of the necessary services, including fueling, aircraft storage, and airport maintenance (e.g., snow plowing and grass mowing). Some airports may have the mowing and snow removal provided by another entity within the airport owner's organization. For example, a local department of public works may provide the mowing or snow removal services. Although this is not being handled by airport staff, it is still being handled within the airport owner's jurisdiction. Airport owners may also provide ground transportation (e.g., a rental or courtesy car) and aircraft storage with airport-owned hangars available to lease. In this scenario, owners typically do not provide aircraft rentals, flight training, charters, or aircraft maintenance. These types of services are most often provided by an FBO or SASO.
- **FBO/SASO-provided services:** An FBO or SASO often provides services such as aircraft rentals, flight training, charter operations, and aircraft maintenance. FBOs may be contracted by the airport owner to handle the additional operational responsibilities of an airport (e.g., fueling, snow plowing, mowing, and aircraft parking). This may also include staffing the terminal

building and/or being charged with managing the hangar storage for the airport. Typically an FBO is distinguished as a business that provides fuel, pilot, and passenger accommodations along with aircraft servicing. A SASO usually provides aircraft maintenance, rentals, charter, flight training, and other aviation services.

- **Contracted Services:** In some situations, airport owners may contract for various services usually maintenance-based. For example, an airport may contract for mowing or snow removal.

Often, larger and busier airports supporting GA traffic have at least one FBO, if not several, to provide services and facilities to airport users for a fee. FBOs are common at these types of airports because such airports have higher traffic counts and, consequently, a larger opportunity for profit. At smaller airports, there may be only a single FBO that offers limited facilities and services, or no FBO at all. This can affect the options for providing services and should be considered during the business planning efforts of an airport.

The maintenance and expansion of critical airport infrastructure (e.g., runways, taxiways, and NAVAIDS) are usually the responsibility of the airport owner if it is a public-use airport included in the NPIAS. Airport owners are typically eligible to receive funding to maintain the critical infrastructure and to develop additional infrastructure through the state and federal airport improvement grant programs.

No single method has been proven to work for every airport. Each airport is unique in its needs, the vendors available to provide services, and how it can meet user needs. These issues must be assessed for each airport to determine the most effective model for providing services.

CHAPTER 3

Airport Planning—General

The key to successful GA facility development is planning. The FAA describes airport planning as “a systematic process used to establish guidelines for the efficient development of airports that is consistent with local, state and national goals. A key objective of airport planning is to assure the effective use of airport resources in order to satisfy aviation demand in a financially feasible manner.” An organized and comprehensive planning process helps avoid common pitfalls in developing GA facilities. Chapter 2 described what general aviation is and the types of GA facilities commonly found at GA and commercial service airports. This chapter describes the types of planning that affect GA facilities at airports and why planning is important. Chapters 4 and 5 more specifically discuss the planning of GA facilities.

Four main planning documents lay the foundation for GA facility development. These documents, to be discussed in more detail in this chapter, are as follows:

- Airport Strategic Plan
- Airport Master Plan
- Airport Layout Plan (ALP)
- Various Environmental Plans

ALPs and environmental reviews are required by the FAA to receive federal funding. In addition to the planning documents noted above, other planning efforts may influence GA facility planning at airports. These include

- **State/Regional System Plans.** State and Regional System Plans use a top-down approach to airport planning and evaluate how the airports within a specific state or region relate to each other. Generally speaking, a system plan helps to define the functional role an airport plays within a state or region and provides facility development guidance from a big-picture perspective. These system and regional plans, along with the FAA’s ASSET Study referenced in Chapter 2 often describe airports based on their use within the system. These plans also identify typical facilities associated with commercial service and GA airports. Airport owners can reference these documents as they plan development at their airports.
- **City/County Land Use Planning and Zoning Ordinances.** Incompatible land uses and conflicts between airports and their adjacent communities are one of the largest threats to airports. Compatible land use is vital for successful protection and promotion of airports. Local planning documents (e.g., comprehensive plans, zoning ordinances, and zoning maps) should incorporate the airport, as well as consider the airport’s needs related to safety and protecting the investment of the facilities at the airport.

Planning is conducted at airports to

- Meet current and future demand
- Promote safe and efficient airport operations

- Fulfill the prerequisites for FAA project funding
- Determine the most cost-effective way to implement facility improvements
- Ensure the facilities fit into the community and regional vision

Errors commonly made with regard to airport planning include

- Being unprepared
- Lack of foresight
- Inflexibility/rigidity
- Too narrow a focus and not considering the big picture relative to long-term needs
- Non-integrated approach among airport facilities
- Not recognizing the economic implications
- Inconsistency with local land use plans and zoning ordinances
- Outdated planning documents or piecemeal planning projects
- Not understanding true demand or developing unrealistic plans
- Poor communication with state DOT and/or FAA
- Not involving all stakeholders throughout the entire planning process

Although these mistakes can occur regardless of type and size of airport, they are more commonly seen when planning for GA facilities. Specific examples include

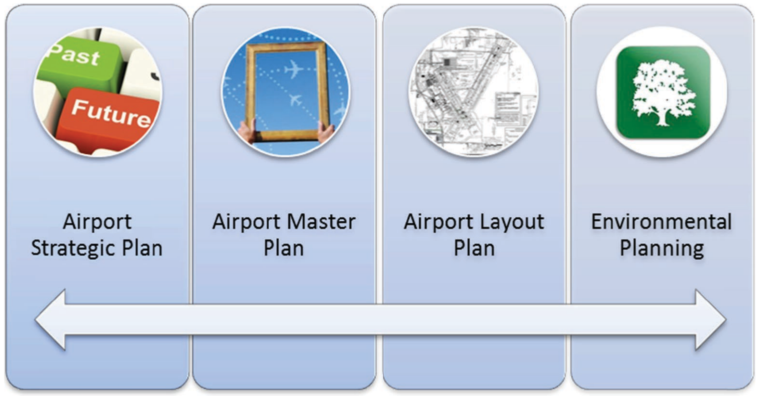
- Lack of foresight (e.g., releasing/selling land that should be kept for future airport development).
- Inflexibility (e.g., developing hangars and a hangar layout that accommodates existing aircraft types/mix or for a specific tenant and not considering if the aircraft fleet mix will change in the future).
- Non-integrated approach (e.g., not considering traffic flows to hangars, FBOs, and terminals when developing the taxiway system or location of fuel farms; comingling of aircraft and vehicles).
- Not recognizing economic implications (e.g., locating FBOs too close together which can cause confusion among transient operators and "turf wars" between FBOs).
- Piecemeal planning (e.g., not considering existing planning documents when a developer approaches an airport to build hangars. Smaller airports are sometimes happy to have any development occur and do not consider how the development plans fit the vision of the airport for the long term).
- Unrealistic planning (e.g., if an airport and the community do not understand the true demand associated with the airport market area, airport planning documents can be overambitious and leave an airport with facilities that are extremely difficult to fund or get built or that result in an overbuilt airport with unused or empty facilities).

Four main planning documents are used for planning airport facilities. These planning documents (airport strategic plan, airport master plan, ALP, and environmental planning) are specific in their purpose, can be developed at various points during the lifecycle of the airport, and relate to each other (see Exhibit 3-1). These documents are used by both commercial service and GA airports.

The planning documents identified affect how GA facility planning is conducted and help airports develop in a focused and orderly fashion. Further, airports can also be sustainable. Sustainability is defined as the capacity to endure. Within the context of development, in 1987 the United Nations defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The FAA has identified three core principles to airport sustainability:

1. Protecting the environment
2. Maintaining a high and stable level of economic growth
3. Social progress that recognizes all stakeholders' needs

Exhibit 3-1. Key airport planning documents.



Airport sustainability planning makes sustainability a "core objective rather than a secondary consideration" during planning. By weaving sustainability throughout planning, airport owners can make more informed decisions about facilities. Chapters 4 and 5 provide detailed guidance on how to develop specific GA facilities. This chapter summarizes the key planning documents that can affect considerations and decisions to be made when developing GA facilities at airports.

Airport Strategic Plan

Simply put, an airport strategic plan sets the overall vision for the airport and identifies long-term strategic goals for the airport. Such a plan considers how an airport fits into a community or region's vision for the future economic viability and identifies the future needs of the airport. TRB's ACRP researched and provided practical guidance to airports on how to approach airport planning strategically. These documents (*ACRP Report 20: Strategic Planning in the Airport Industry* and *ACRP Report 77: Guidebook for Developing General Aviation Airport Business Plans*) provide airport managers and airport owners with guidance on developing and implementing an airport strategic plan.

An airport strategic plan and airport business plan can help keep an airport owner and management focused on achieving the community's adopted vision and goals for the airport. By using a strategic approach to airport development, local airport leaders can better make informed decisions regarding the management, operation, and development of the airport. A strategic plan can lay the foundation for all other airport planning documents (e.g., business plan, master plan, and land use plan) as its elements are interrelated and can be translated into other planning processes. The strategic plan is often not a separate document but an overall strategy identified in the airport master plan and airport business plan.

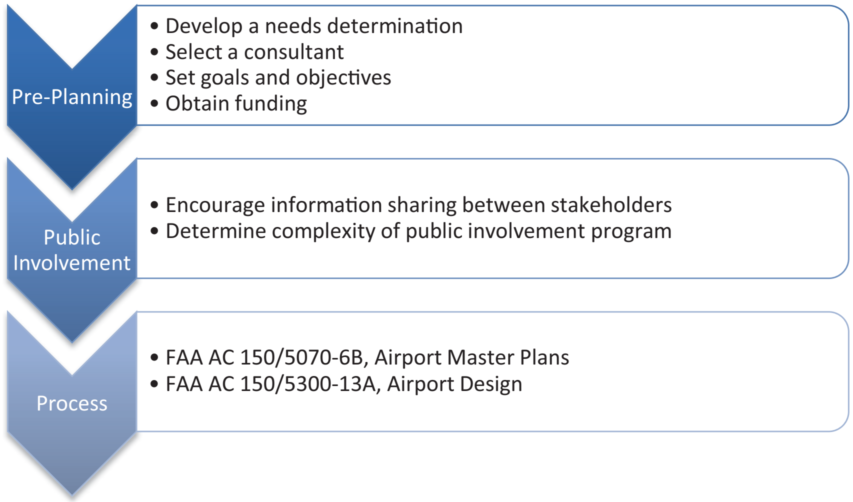
The four basic elements within the strategic plan process are pre-planning, analysis, implementation, and monitoring. The plan then provides a "high-level statement of strategic directions and priorities." The benefits of incorporating this plan into the overall airport planning and GA facility planning process is the development of a framework from which to prioritize projects and the ability of the airport and its policymakers to evaluate the needs of the airport comprehensively.

Airport Master Plan

An airport master plan is essentially an airport's blueprint for long-term development (typically with a 20-year horizon). The goals of a master plan as identified by the FAA are to

- Represent existing airport features, future airport development, and anticipated land use graphically

Exhibit 3-2. Airport master planning steps.



Source: FAA AC 150/5070-6B, *Airport Master Plans*

- Establish a realistic schedule for implementing the proposed development
- Identify a realistic financial plan to support development
- Validate the plan technically and procedurally through investigation of concepts and alternatives on technical, economic, and environmental grounds
- Prepare and present a plan to the public that addresses all relevant issues and satisfies local, state, and federal regulations
- Establish a framework for a continuous planning process

Airport master plans are developed to address key issues, objectives, and goals pertinent to the airport's development. Prior to following the guidelines set forth by the FAA in AC 150/5070-6B, *Airport Master Plans*, airport owners need to go through a pre-planning process and determine the need for public involvement throughout the entire process. Exhibit 3-2 shows steps for airport sponsors and management to follow when undertaking an airport master plan project.

Pre-planning

Airport owners and management go through this informal process before formally beginning an airport master planning process. Basic steps in the process include

1. **Developing a needs determination.** Airport policymakers and management usually identify the need to conduct a planning study based on a deficiency of facilities or services that currently exists at the airport or within their existing plan; another planning document (e.g., strategic airport plan, airport business plan, or statewide/regional system plan) has identified the need to conduct a study to evaluate deficiencies at the airport; or airport users have identified facilities needed (new or updated/expanded) to meet their operational needs. As the airport owner/management develops the needs determination, they will also determine the type of study that will be conducted and the level of effort needed to complete the study.
2. **Selecting a consultant.** After needs have been determined and the type of study to be conducted has been identified, the airport will typically select a consultant to conduct the work. The FAA and the Airport Consultants Council (ACC) both provide guidance for selecting a qualified consultant (FAA AC 150/5100-14, *Architectural, Engineering and Planning Consultant Services for Airport Grant Projects* and Airport Consultants Council *Guidelines to Selecting Airport Consultants*).

3. **Setting goals and objectives.** One of the first tasks to be completed once a consultant is selected is to define the goals and objectives for completing the airport master plan and developing the scope of work for the project.
4. **Obtaining study funding.** If eligible for federal or state funding, the final step before beginning the project is to apply for funding through a federal or state grant application.

Thoughtful pre-planning and early coordination with the FAA are key to a successful airport master plan project.

Public and Stakeholder Involvement

Once pre-planning has been completed, the next task is to determine the complexity of a public involvement program. The earlier a public involvement program is initiated, the more effective it will be in the master planning process. The general public is often unaware of the contributions an airport provides to the community, including how an airport's infrastructure strengthens the local economy. When airport terminal areas or runways need to expand to support existing and future demand, the public sometimes views the expansion negatively. Therefore, it is vital to understand airport user needs, perspectives of the public and state and federal review agencies, and the tradeoffs between the alternatives being considered. Developing this understanding, sharing this information among stakeholders, and considering the input received provides a strong foundation for the projects identified in the airport master plan. This sharing of information should be documented and included within the master plan as an appendix as recommended in Chapter 4—Public Involvement of FAA AC 150/5070-6B, *Airport Master Plans.*

Public involvement is essential to the success of an airport master plan project. Several tools/techniques can bring the public and key stakeholders into the master planning process. These tools/techniques can include but are not limited to

- **Master Plan Advisory Group.** The Master Plan Advisory Group provides input on information being considered and findings being developed throughout the airport master planning process. The group can help assess issues and needs and can act as a sounding board for proposed development alternatives.
- **Public Information/Outreach Meetings.** The purpose of these meetings is to gather input and inform the broader public and other stakeholders of the progress of the airport master plan project.
- **City Council, Airport Authority, and/or Advisory Commission Meetings.** These meetings provide regular updates to the City Council, Airport Authority, and/or Advisory Commission on key information and the status of the planning, as well as obtaining input.
- **Public Awareness Campaign.** A public awareness campaign gets word to the general public about the airport and the airport master plan project. The campaign can include developing a project website that provides user-friendly, easy internet access to information about the project, or it can be a project newsletter that provides written information about the project to adjacent landowners, city officials, and other interested stakeholders.

The level of public involvement should be proportional to the complexity of the project and level of interest by the public. Examples of the different types of stakeholders that could be included are listed below:

- Airport Owner Representatives (e.g., airport authority, board, or commission representatives); Airport Manager; and key airport owner staff (e.g., city engineer, Economic Development Director)
- State DOT Aviation/Aeronautics Personnel
- FAA Personnel (e.g., Airports District Office, and Air traffic control tower, if applicable)

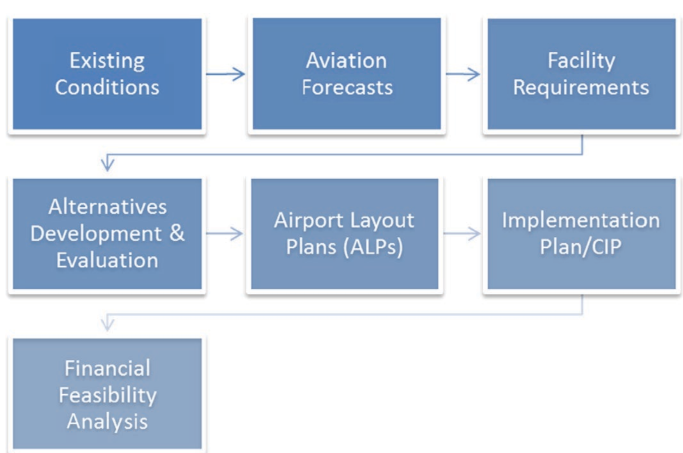
- Users and Tenants
- Interested Groups (e.g., Adjacent land owners and/or developers, Chamber of Commerce representatives, and neighborhood associations)
- Other Governmental Agencies (e.g., local political representatives; Native American tribes; state, regional, and metropolitan planning agencies; the TSA)

Process

The FAA Airport Master Plan AC (AC 150/5070-6B, *Airport Master Plans)* provides detailed guidance on developing an airport master plan. The FAA recognizes that each airport is different and that each "particular study will vary depending on the size, function, and challenges facing the study airport." However, each airport master plan study will contain the same basic components (see Exhibit 3-3):

1. **Existing Conditions.** This first task in the master plan process becomes the foundation for the study because it researches and documents information not only about the airport (existing airside and landside facilities) but includes relevant information about the airport's local/surrounding communities and an environmental overview.
2. **Aviation Forecasts.** There are different types of GA aircraft (e.g., single-engine, multi-engine, and jet) and there are different types of GA activities. Developing projections of aviation demand based on these aircraft and activities is essential to planning and important in understanding the current needs of the airport and in determining future facility needs. Components of aviation demand are typically projected for 5-, 10-, and 20-year periods and include aircraft operations, based aircraft, and aircraft fleet mix. The results of these projections are used to determine facility needs. Many methods can be used to forecast aviation demand. In August 2002, TRB published an E-Circular (*Aviation Demand Forecasting—A Survey of Methodologies*) documenting forecast methodologies used within the industry. Also, *ACRP Synthesis of Airport Practice 2—Airport Aviation Activity Forecasting* provides an overview of practices and methods used in airport activity forecasting. Chapter 4 of this Guidebook identifies various indicators of activity considered when developing forecasts. Chapter 5 provides guidance on how aviation activity relates to the size or planning of specific types of GA facilities.
3. **Facility Requirements.** An airport's ability to accommodate existing and projected activity is determined by using approved FAA capacity methods. Capacity is the level of activity at

Exhibit 3-3. Basic components of an airport master plan.



Source: FAA AC 150/5070-6B, *Airport Master Plans* which unacceptable delay occurs. This is compared to the aviation forecasts to determine if any additional capacity is needed in terms of facilities. By comparing the inventory of existing facilities and results of the capacity analysis to the forecasts, the required facilities needed for the airport can be identified. Typical facilities evaluated include but are not limited to runway length, width, and alignment; aircraft parking; fuel storage and location; security; access; NAVAIDS; and utilities. Numerous FAA documents (AC 150/5300-13, *Airport Design;* 14 CFR Part 77*, Safe Efficient Use, and Preservation of Navigable Airspace;* AC 150/5060-B, *Airport Capacity and Delay*, and AC 150/5070-6B, *Airport Master Plans*) provide guidance to airports on identifying appropriate facilities and ensuring they meet FAA standards. Future facility requirements will provide the basis for evaluating alternative development actions that might be adopted to satisfy the need for improved facilities.

4. **Alternatives Development and Evaluation.** Based on the results of the previous task, feasible alternatives for developing all facilities on the airport will be evaluated (Chapter 2 provided examples of various types of GA facilities and Chapters 4 and 5 will provide guidance on planning for these facilities). Alternatives evaluated will take into consideration the long-term development of the airport while planning for near-term implementation of projects. Each of the identified alternatives will be compared based on overall merits and deficiencies and then ranked quantitatively and qualitatively according to their ability to meet the goals of the FAA (e.g., safety, capacity, and compatibility). Once a preferred development has been selected, the next step is to update the airport's airport layout plan (ALP) to illustrate all existing and planned facility development at the airport.
5. **Airport Layout Plans (ALPs).** An ALP is a package of plans that present the existing and future development of the airport. As a condition of receiving grants, FAA requires airport sponsors to maintain a current ALP at all times. Developing an ALP requires close coordination between the airport sponsor, the FAA, and the consultant to ensure that the ALP is comprehensive and meets FAA design standards. The FAA provides guidance (FAA Order 5100.38*, Airport Improvement Program Handbook;* AC 150/5300-13C*, Airport Design* and AC 150/5070-6B, *Airport Master Plans*) on developing an ALP. The specific plan sheets that comprise an ALP plan set will vary with each airport planning project, depending on the level of effort identified in the pre-planning process. Typical plan sheets in an ALP set include the following:
   - Cover Sheet. This plan sheet has the airport's name on it and an index of drawings included in the plan set.
   - Airport Data Sheet. This airport data sheet summarizes important existing and planned airport information.
   - Airport Layout Plan. The ALP sheet is developed using guidelines identified in FAA *AC 150/5300-13, Airport Design.* Features depicted include prominent airport facilities (e.g., runways, taxiways, buildings, and parking areas) and any facilities to be phased out or added in the future. Areas available for aviation development and services (e.g., airport maintenance areas) and rotorcraft operating areas are also defined on the ALP.
   - Airport Airspace Drawing. The airspace plan or FAR Part 77 airspace drawings depict penetrations of the FAR Part 77 imaginary surfaces.
   - Inner Portion of the Approach Surface Drawing. Runway approach drawings depict plan and profile views of the runways and governing approach surfaces. These plans include existing and future safety areas identified in FAA AC 150/5300-13, *Airport Design.*
   - Terminal Area Plan. A detailed terminal area plan depicts aircraft parking/tie-down areas, fueling facilities, aircraft storage/hangars, buildings, and security facilities.
   - On-Airport Land Use Drawing. The on-airport land use drawing divides the airport into aviation-related functional areas and can include noise contours to depict the level of sound occurring on the airport as a result of aircraft operations.
   - Off-Airport Land Use Drawing. The off-airport land use drawing depicts existing and future land use of the parcels of land surrounding the airport.

- Airport Property Map or "Exhibit A." The airport property map shows the boundary of the airport and any avigation easements owned by the airport.
- Runway Departure Surface Drawing. This drawing depicts departure surfaces as defined by FAA AC 150/5300-13, *Airport Design.*
- Utility Drawing. The location and capacity of major utilities on the airport and in the surrounding area are shown on this drawing.

6. **Implementation Plan/Capital Improvement Plan (CIP).** By this task, the master plan process has identified the various projects and facilities necessary to implement the preferred alternative. Cost estimates associated with this list of projects are developed to help determine the desired sequencing of projects over the planning periods. A Capital Improvement Plan (CIP) is developed as part of this task to help determine when projects will occur.
7. **Financial Feasibility Analysis.** The final task in the master plan process is the financial evaluation of the benefits and costs associated with the recommended development plan. This financial analysis can include the following:
   - Projection of expenses, revenues, and debt service;
   - Assessing rates and charges; and
   - Establishing financial feasibility.

Standalone Airport Layout Plan

An ALP shows the existing and proposed airport boundaries and facilities (airside and landside) and the location of existing and proposed non-aviation areas and improvements. Airports are required by the FAA as a condition of receiving grants to keep ALPs up to date at all times. The FAA defines an ALP's purpose as the following primary functions:

- To receive financial assistance under the AIP grant program and to receive Passenger Facility Charges (commercial service airports only),
- To create a blueprint for airport development in accordance with design standards and safety requirements,
- To become a public document that serves as a record of aeronautical requirements both present and future,
- To enable the airport sponsor and the FAA to plan for facility improvements, and
- To serve as a working tool for the airport sponsor.

While an ALP is part of a master plan, an update to an ALP can be done without going through the full master plan process. A standalone ALP project is viewed as appropriate by the FAA when "fundamental assumptions of the previous master plan have not changed." Using the ALP checklist provided in Appendix F of the FAA AC 150/5070-6B, *Airport Master Plans*, airport sponsors and management can develop the scope of work for a new or updated ALP and move forward with a standalone ALP. A standalone ALP typically involves fewer components than a full master plan; however, it still requires close coordination between the airport sponsor, the FAA, and the consultant preparing the ALP. The basic components of a standalone ALP project follow:

- *Narrative Report.* This report explains the changes to the ALP and contains the following elements:
  - Basic aeronautical forecasts
  - Basis for proposed items of development
  - Rationale for unusual design features and/or modifications to FAA Airport Design Standards
  - Summary of the three (short-term, mid-term, long-term) stages of development and drawings of the major items of development in each stage
  - An environmental overview to document environmental conditions that should be considered in analyzing development alternatives and proposed projects

- *ALP Set.* The ALP set contains the following elements:
  - Airport Layout Drawing
  - Airport Airspace Drawing
  - Inner Portion of the Approach Surface Drawing
  - Terminal Area Drawing
  - Land Use Drawing
  - Airport Property Map
  - Airport Departure Surfaces

Environmental Planning

Signed into law in 1970 by President Richard Nixon, the National Environmental Policy Act (NEPA) has become the cornerstone law by which we protect our environment. The Act assures that proper technical, economical, and environmental analyses are performed before development occurs. The FAA's Airport Environmental Program helps airports implement NEPA regulations as well as other federal environmental laws. Each state also has environmental laws that should be followed. A basic overview of how environmental considerations fit into the overall planning process is discussed in this section.

Ideally, when airports are planning the development of their facilities, they follow state and federal environmental regulations, as well as, including the FAA early in the process of planning facilities. FAA Order 5050.4B, *NEPA Implementing Instructions for Airport Projects*, emphasizes the importance of airport planning during the environmental process because it helps to

- Define the airport sponsor's proposed project
- Describe the purpose and need and identify reasonable alternatives to address the purpose and need
- Provide analyses of potential environmental impacts the proposed project and its reasonable alternatives could cause
- Develop the full scope of reasonably foreseeable airport development critical to the Federal action's cumulative impact analysis

Planning data and analyses conducted as part of strategic plans, airport master plans, and ALPs that can influence environmental analyses include

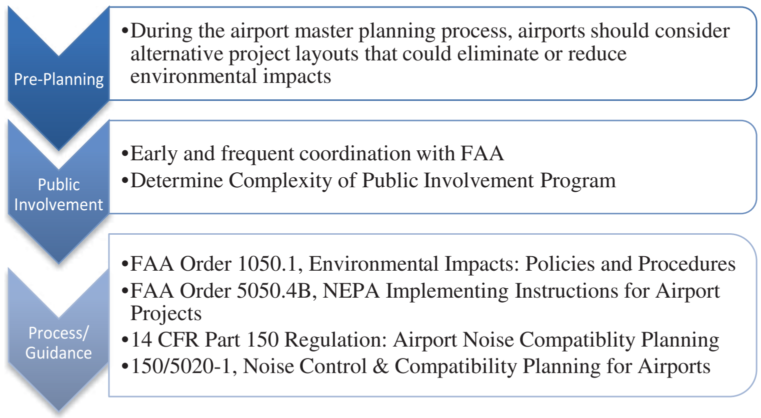
- Inventory data of existing facilities
- ALP showing proposed development
- Aviation/aeronautical forecasts
- Design aircraft and fleet mix
- Facility requirements
- Planned project linkages versus independent utility

As with the planning documents, key steps should be followed to ensure a successful project (see Exhibit 3-4). For environmental planning these steps include pre-planning, public involvement, and process/guidance.

FAA Orders 1050.1, *Environmental Impacts: Policies and Procedures,* and 5050.4B, *NEPA Implementing Instructions for Airport Projects*, provide guidance for compliance with NEPA regulations. There are three types of environmental reviews which airports can complete based on the complexity and nature of a development project. FAA Order 1050.1 identifies these major levels of review as

- **Categorical Exclusion (Cat Ex).** This first level of review is the simplest of the three. If a project or action meets certain criteria that a federal agency has previously determined as having

Exhibit 3-4. Key steps in environmental planning.



Source: FAA AC 150/5070-6B, *Airport Master Plans*

no significant impact, the project or action can be categorically excluded from a detailed environmental analysis.

- **Environmental Assessment (EA).** The next level of review is when a project or action must undergo an EA to determine whether or not a federal undertaking would significantly affect the environment. If the answer is no, the FAA issues a Finding Of No Significant Impact (FONSI). The FONSI may address measures that may have to be taken to mitigate any impacts.
- **Environmental Impact Statement (EIS).** An EIS is the most detailed of environmental reviews. At the end of the EIS, the FAA prepares a public record of its decision addressing the findings of the review. An EIS is conducted because (1) an EA determines that the environmental consequences of a proposed project or action may be significant, (2) FAA determines that the project is environmental controversial, or (3) FAA anticipates the project may significantly impact the environment.

In addition to following NEPA regulations, other types of environmental planning and requirements that could affect GA facility development include

- **Aircraft Noise Compatibility Planning.** FAR Part 150 is the administrative rule promulgated to implement the *Aviation Safety and Noise Abatement Act of 1979.* FAR Part 150 sets requirements for airport operators who choose to undertake an airport noise compatibility study with federal funding assistance. Part 150 provides for developing noise exposure maps (NEM) and a noise compatibility program (NCP). Terminal areas, hangars, and aprons are examples of GA facilities that serve as concentration points for aircraft activity and are include in the analyses conducted in Part 150 study.
- **Compatible Land Use Planning.** The most successful methods for regulating land use incompatibilities surrounding airports are local planning efforts including comprehensive plans, zoning ordinances, and airport master plans. The FAA's *Land Use Compatibility and Airports, A Guide for Effective Land Use Planning* provides guidance to airports on how to establish and maintain compatible land uses around airports. Land use planning issues can and should be considered during the airport master planning process.

Some states have environmental requirements in addition to and/or more stringent than federal environmental approval requirements.

CHAPTER 4

General GA Facility Planning

GA facility planning is often done within the context of an airport master plan or ALP update; however, some GA facility planning is done solely for one facility. Chapter 4 will help readers with planning GA facilities, regardless of the context in which the planning is done.

An old saying in the airport industry is: "If you've seen one airport, you've seen one airport." Airports are different. They have different community goals, geometry, aviation activity, climates, engineering and environmental challenges, and different financial capabilities. As a result, planning of GA facilities cannot be done in a cookie-cutter manner. This chapter outlines the basic principles of a good plan, identifies documents that govern the plan, highlights activity indicators that drive the plan, discusses some of the considerations that go into planning, and offers a step-by-step process.

Although GA facility planning is often done as part of a comprehensive airport master plan (see Chapter 3), it can be done separately. Regardless of how it is done, Chapter 4 provides useful direction in planning for these facilities. Chapter 4 focuses on an overall GA facility plan for an airport. Chapter 5 provides guidance about specific layout and sizing of each individual type of facility.

General aviation includes various users and activities (e.g., corporate flight departments, recreational users, business flying, flight training, agricultural applications, law enforcement, FBOs, and special aeronautical service operators). The airport and users generally need the following facilities:

- GA terminal building
- Aircraft parking apron
- Hangars
- Fuel facilities
- Access roads
- Automobile parking
- Administration buildings
- Maintenance equipment storage
- SRE storage
- Wash racks
- Fixed-base operations
- Helicopter parking

Airports offer different opportunities for planning GA facilities:

- Some develop in an orderly and focused manner based on an airport master plan. Others have none or very old master plans and they develop piecemeal as the need arises.
- Some have the opportunity to develop unconstrained sites. Others have to squeeze in development wherever they can.
- Some have old surplus property infrastructure and a lot of it. The challenge is often to determine how much to maintain rather than what and where to build new facilities.

Basic Principles

Regardless of the context in which planning is done, the following overarching principles can help guide the development of a good GA facility plan. These principles can be used to evaluate a plan or plan alternatives:

- **Safety.** Facilities should be developed per FAA runway/taxiway separation geometric standards, creating no hazards to air navigation, nor obstructing any line-of-sight, and minimizing the opportunity for runway incursions. (Example of poor planning: locating a new terminal area development that blocks line-of-sight between intersecting runways.)
- **Efficiency.** The plan should maximize development space, reflect consideration of airfield traffic flow, minimize conflicts between operations, and ensure that ground access is efficient. (Example of poor planning: locating two FBO areas adjacent to one another on the same apron, causing "turf" battles and confusing customers.)
- **Economics.** The plan should reflect consideration of benefits versus cost, reasonable construction costs, a reasonable financing plan, consideration of opportunities for generating airport revenue, and opportunities for competition. (Example of poor planning: constructing a large hangar development without clear indication of its need or potential revenue to help offset the cost of development.)
- **Expansion.** Facilities should be planned so that once built they can be expanded if necessary. (Example of a plan often resulting from site constraints: buildings/hangars around the perimeter of an apron, not allowing future expansion of the apron.)
- **Balance.** The GA facilities plan should be consistent with the airport's GA Airplane Design Group and runway/taxiway capability. The capacity of each facility should be in balance with that of the other facilities as appropriate. The plan should reflect the existing and forecast facility requirements. (Example of an unbalanced plan: development of apron and hangars for aircraft larger than the existing or planned runway capability.)
- **Consistency.** The GA facilities plan should be consistent with the airport vision, community goals and plans, the ALP, and the intent of FAA grant assurances and established airport minimum standards.

GA facility plans and alternatives under consideration should be evaluated against the above principles. Both overall plans and individual facility plans can be evaluated using the checklist provided in Exhibit 4-1, with specific facility plan evaluation supplemented by individual checklists (Chapter 5).

Key Governing Documents

Several documents can be helpful with the planning of GA facilities; some have been referenced earlier in this Guidebook. These include but are not necessarily limited to those listed in Appendix C. However, several documents could be called "governing" given that they provide strong direction and requirements for the overall planning of GA facilities. These include

- The airport owner's vision, strategic plan, business plan, and community goals for the airport and its facilities.
- The airport master plan and ALP. GA facility planning is often done as part of an airport master plan, but whether it is or not, certain elements of the master plan (e.g., activity forecasts) drive facility requirements and, thus, the plan. All GA facility plans should be consistent with the latest approved ALP or be an integral part of the preparation or updating of the ALP. FAA provides guidance for master plans in AC 150/5070-6B, *Airport Master Plans.* A standard ALP checklist is available on the FAA Office of Airports website.

Exhibit 4-1. GA facility development plan evaluation checklist.

Safety	*Yes or comment*
• Meets FAA geometric standards	
• Offers minimal opportunity for runway incursions	
• Does not conflict with navigational aids	
• Does not obstruct line-of-sight criteria • Is not an airspace hazard	
Efficiency	
• Maximize development space	
• Will not cause conflicts between GA and air carrier traffic	
• Does not cause conflicts between FBOs/SASOs	
• Ground access is efficient and auto parking is available	
• Service vehicles can maneuver easily	
Economics	
• Benefit is worth the cost	
• Reasonable funding plan is in place	
• Offers reasonable opportunities for generating revenue	
• Does not restrict competitive environment	
Expansion	
• Layout of facilities provides for expansion	
• Does not adversely degrade opportunity for expansion of nearby facilities	
Balance	
• Facility plan is in balance with airfield design and runway/taxiway capability	
• Each facility should be in balance with other facilities	
• Facilities should be planned to meet existing and future requirements	
Consistency	
• The plan is consistent with airport vision, community goals, and plans	
• The plan is consistent with the ALP	
• The plan should be consistent with the intent of FAA grant assurances	
• The plan does not conflict with airport minimum standards	

- Local zoning ordinances, land use plans, noise compatibility plans, transportation plans, and building codes. These documents influence the specific location of facilities and architecture/designs of facilities.
- FAA AC 150/5300-13A, *Airport Design.* This document provides the geometric standards for the location of facilities (e.g., terminal buildings, hangars, and parked aircraft) relative to runways and taxiways. These standards help ensure that a plan does not adversely impact an airport's safety and efficiency.
- State airport system plans and state requirements. Some state system plans identify the role of an airport and the specific size of desired GA facilities. A state system plan sometimes drives a state aviation agency's decision to fund certain facilities.
- Airport minimum standards. Most airports have adopted standards that specify the minimum size of GA facilities and the types of services offered by commercial activities. These minimum standards will influence the plan. Conversely, if the minimum standards are not reasonable, this can often be addressed during development of the plan and the minimum standards then changed.

- FAA and state Grant Assurances. Airport sponsors make several assurances as a condition to receiving federal and state funds. The intent of these assurances is addressed in many of the principles and planning considerations discussed throughout this Guidebook.
- Airport leases. The existing leases for facilities on an airport can play a large part in shaping the future of an airport. Often, the airport owner has to make do with what exists as opposed to tearing facilities down and building new expensive facilities.

GA Services—Airport Ownership/Operation Models

The ownership/operation models for GA services directly influence (1) the type, size, and location of planned facilities; and (2) the process and the extent to which facilities are planned and developed. These models include

- Facilities owned and operated by the airport owner who also provides aircraft and pilot services at the airport.
- Facilities owned by the airport owner and leased to a private firm that manages the services.
- Some facilities owned by the airport owner and some by an FBO.
- All facilities are FBO owned and operated.
- The airport allows specialized aviation service operations (SASOs) for some activities (e.g., flight instruction, aircraft maintenance, charter, rental, aerial applications, and medical transport).
- The airport typically allows SASOs for any of the airport operating models already listed.

Airport owners often grant one or more FBOs or SASOs the right to conduct a commercial business on the airport and provide aeronautical services (e.g., tie-down and parking, fueling, hangaring, aircraft maintenance, aircraft rental, and flight instruction). FBOs and SASOs are often the primary provider of these services and are typically on leasehold property. Airports sometimes lease large tracts of land to FBOs and the FBO plans and develops the land for GA facilities within its leasehold. These facilities generally include a building with public/pilot service areas, offices, hangar(s), apron, and auto parking. FBOs sometimes lease space within an airport-owned GA terminal building and operate from there. Sometimes an airport owns all facilities and contracts with an FBO-like firm to provide services operating from the airport-owned facilities. Airport owners often develop a business plan for the airport to help guide what business model to pursue. *ACRP Report 77: Guidebook for Developing General Aviation Airport Business Plans* provides a good overview of the advantages and disadvantages of the various models.

> Regardless of which ownership/operator model is used, GA facilities should be planned to meet the needs of the GA community. Also, airport owners should have control of the planning/layout of all facilities to ensure future expansion is not impeded.

Planning Considerations

In addition to the principles that make up a good GA facilities plan or in concert with those principles, some of the issues that need to be considered during GA facility planning include

- **Engineering challenges.** Although addressed in detail during the design of facilities, challenges should be anticipated during planning because they will affect the economic and physical feasibility of a plan. Examples of engineering challenges are terrain and drainage.
- **Environmental impacts.** Planned development will require environmental approvals, so the planner will need to consider the environmental impacts of the development and its operation. Examples of impacts are noise on nearby residences, removal of wetlands, and auto traffic that increases air pollution.

- **ALP conformance.** Do not locate planned facilities where they will later have to be relocated.
- **Community acceptability.** Public involvement and community input during planning is important.
- **Future revenue generation.** Some facilities can generate revenue and this should be factored into planning. Examples of revenue opportunities are tie-down fees, hangar rentals, and FBO leases.
- **Airport safety and security.** Clear guidance is available in several resource publications (see Appendix D). Pay particular attention to the possibility of increasing the opportunity for runway incursions. Avoid taxiing directly onto the runway.
- **Proximity to other facilities.** Locate facilities so their operation does not conflict with other facilities. For example, do not put a fuel farm in the middle of a primary aircraft apron.
- **Airport traffic flow.** Anticipate how the location of facilities will cause aircraft to taxi/maneuver throughout the airport.
- **Fleet mix.** Anticipate the diversity in aircraft and assess how that will affect the location, sizing, and layout of facilities.
- **Sustainability.** Consider how new facilities can best achieve sustainability goals.
- **Operational and maintenance requirements.** Consider how facilities will actually be operated and maintained. Involve airport operations and maintenance personnel in the planning. Anticipate the need for service vehicles. Will they be able to maneuver?
- **Utility requirements.** Anticipate the need, location, and feasibility of utilities for the facilities being planned. Major new utilities may also need to be planned.
- **Constructability and phasing.** Required construction methods and phasing may affect the feasibility of a plan. For example, if the construction of new facilities requires temporary closure of a runway, can the airport handle the impact to airport users?
- **Navigational aid impacts.** Many navigational aids have critical areas or visual paths that need to be kept clear of objects.
- **ARFF access.** GA facilities should not impede aircraft/airport rescue and firefighting capabilities.
- **Minimum standards.** Most airports have established minimum standards for operating commercial aeronautical activities. The planner should be familiar with those that relate to sizing of facilities such as hangars, FBO building, or special aviation service providers.
- **Wildlife hazards.** The planner should be aware that new GA facilities (e.g. a water detention pond) may result in creation of wildlife hazards.
- **Grant assurances.** Some FAA AIP grant assurances will affect the overall plan.
- **Aviation trends.** Changes in the aviation industry can have a significant impact on the size, quantity, and type of facilities needed.

Grant Assurances

As a condition to receiving federal grants through FAA's Airport Improvement Program (AIP), airport owners make several grant assurances that become local airport obligations. Airport owners are typically referred to as airport "sponsors" when referring to grant issues. Some state funding programs also have grant assurances. Important federal obligations that flow from these grant assurances and that affect airport planning include

- **Economic nondiscrimination.** Airports, their facilities, and services must be available on reasonable terms and without unjust discrimination. Each FBO at the airport should be subject to the same rates, fees, rentals, and other charges as are uniformly applicable to all other FBOs making the same or similar uses of the airport and using the same or similar facilities. This grant obligation primarily relates to airport operation; however, it can affect the financial aspects of the planning of GA facilities.
- **Exclusive rights.** Airport sponsors may provide certain services to airport users on an exclusive basis; however, sponsors may not permit an exclusive right for the use of the airport to

any person providing, or intending to provide, aeronautical services to the public. FAA states in the grant assurance that the provision of aeronautical services at an airport by a single FBO is not construed as an exclusive right if (1) it would be unreasonably costly, burdensome, or impractical for more than one FBO to provide such services; and (2) if allowing more than one FBO to provide such services would require the reduction of space leased pursuant to an existing agreement between the single FBO and the airport. This grant obligation and the model for providing airport services (i.e., airport owner vs. fixed-base operation) directly affect the planning of airport facilities.

- **Fee and rental structure.** Airport sponsors must maintain a fee and rental structure for the facilities and services at the airport which will make it as self-sustaining as possible under the circumstances existing at the particular airport, taking into account such factors as the volume of traffic and economy of collection. This grant obligation will affect the financial aspects of the planning of GA facilities.
- **Airport revenues.** All revenue generated by the airport and any local taxes on aviation fuel established after December 30, 1987, should be used by the airport for the capital or operating costs of the airport. This grant obligation will affect the financial aspects of the planning of GA facilities. As an example, an airport sponsor cannot build a self-fueling facility and use the proceeds to help build or operate non-airport facilities for the community.
- **Airport Layout Plan.** The airport owner must keep an ALP up to date at all times. The ALP, among other things, should show the location and nature of existing and proposed GA facilities. Further, the airport sponsor should not make or permit any changes or alterations to the airport facilities that are not in conformity with the FAA-approved ALP and that adversely affect the safety, utility, or efficiency of the airport.

The preceding is only an overview of a few of the federal grant assurances. Airport sponsors and those planning airport facilities need to have a good understanding of how grant assurances relate to their airports. FAA offices that oversee grant obligations can help with this understanding if needed.

Financing GA Facilities

Financial planning is a critical part of GA facilities planning. A sound financial plan addresses both the capital funding of the facilities and their operation. It answers key questions such as: How will the capital costs be funded and is developing the plan financially feasible? Will the facilities promote positive economic development of the airport and community? Will the facilities help the airport be as self-sustaining as possible?

Capital Funding of Airport Development

Funding the development of GA facilities typically involves local, state, and federal funding, depending on the type of facility, the legislative authority of the state/federal programs, and the availability of funds. Key sources of funding for GA facilities follow:

- **FAA.** FAA helps fund many of the GA facilities through the Airport Improvement Program (AIP) for airports in the National Plan of Integrated Airport Systems (NPIAS). The AIP was enacted in 1982 and most recently reauthorized in 2012. The legislative authority for the types of facilities, types of airports, and type of funding (entitlement and discretionary) can change each time the AIP federal authorizing legislation changes. Airport sponsors and planners need to contact the local FAA offices that provide AIP grants to determine the current laws regarding eligibility and funding for GA facilities. The federal participation rate varies depending on the type of airport and the current legislation. This rate has varied from 90 to 95 percent over the past several years at GA airports.

- **State funding.** Airport owners and planners should contact the state aviation office that governs the state airport programs to determine the requirements and opportunities for state funding of airport projects. Some states pay for half of the nonfederal costs of projects and some fund all of that cost.
- **Local funding.** Local funds typically cover the cost of projects not funded with federal or state grants. This can be a substantial sum for projects not eligible for any federal or state grants. Sources of local funding might include general city/county funds or various bonds such as (1) general obligation bonds used for debt financing of capital development, (2) revenue bonds secured from the revenue generated from the specific development project, and (3) industrial development bonds issued to finance facilities that are in turn leased to a private entity or user at terms equal to the debt service of the bond.
- **Other funding sources.** Some airports have been successful in obtaining economic development grants or loans for airport development. Some have received donations from private individuals or corporations for specific facilities such as a GA terminal building. GA airports that serve smaller aircraft rely heavily on private individual financing for non-eligible AIP improvements, particularly capital projects that can generate revenue for the airport. An example of the latter might be private hangars built on land the airport leases to the private individual or corporation.

Airport Operating Budgets

Good financial planning of GA facilities includes not only a capital funding plan but also anticipation of an operating budget that includes the revenue and expenses for the facilities. Principal elements that make up an airport's revenues and expenses follow. (Whether a private developer or the airport owner builds and operates facilities such as hangars, many of these financial items apply to typical GA airports. These items apply to air carrier airports too but the airport operating budgets for those airports include many other items such as air carrier leases, landing fees, and large concession leases.)

Revenues include

- Fuel sales or fuel flowage fees received from private entity
- Hangar rent
- Tie-down rent
- Ground rents and leases
- Interest earnings
- Miscellaneous revenue (e.g., penalty payments)

Expenses include

- Salaries and benefits for employees
- Fuel purchases
- Fuel flowage fees (an expense for private entities, paid to airport owner)
- Professional and contract services
- Utilities
- Telecommunications
- Office supplies
- Repairs and maintenance services
- Overhead
- Insurance
- Taxes

Other items to consider in budgets are

- Loan payments (principal and interest)
- Federal and state grants
- Capital project expenses
- Fixed-asset depreciation

Good financial planning normally includes preparation of a project pro forma which is a detailed projection of the effect of a project on the financial health of the airport. In other words, does it make good business sense to build the project and are the financial aspects positive enough to warrant third-party investment? A typical pro forma shows how the projected revenues (e.g., fuel, hangar rent, other rent, property tax, other) by year compare to expenses (e.g., salaries/benefits, fuel purchase, utilities, overhead) and other costs such as loan principle and loan interest. A preliminary pro forma is often prepared as part of a business plan and may be done prior to doing a detailed layout plan for specific GA facilities.

Organizations such as the Aircraft Owners and Pilots Association (AOPA) provide guidance to airports regarding the financial aspects of airports and airport development. AOPA's "Aircraft Hangar Development Guide" provides a sample hangar project pro forma analysis.

GA Facility Planning

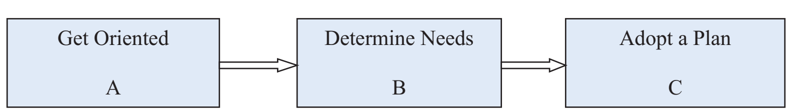
GA facility planning is often done within the context of an airport master plan or update to the airport layout plan for the airport. It sometimes is done as a standalone effort for specific facilities. Regardless of how GA facility planning is done, the following ABC process can be used (see Exhibit 4-2).

Phase A—Get Oriented

The purpose of this first phase is to get oriented about how the GA facility plan fits into other airport planning activities, determine who the key players are, and become familiar with important documents that will govern the planning effort. Phase A complements the pre-planning and stakeholder involvement steps in the airport planning processes for an airport master plan or ALP update (see Chapter 3). Specific steps in Phase A include

1. Identify the airport's vision and strategic goals, GA services and facilities at the airport, business plans, and how the GA facilities plan relates to any previous or ongoing planning work such as an airport master plan.
2. Identify the team members and stakeholders; adopt a framework for decision-making and approval. Team members or stakeholders that typically have input to a plan include the following:
    - Airport policymaking board
    - Airport management and staff
    - Airport advisory board and/or community groups
    - Consultant

Exhibit 4-2. The ABC process.



- Local architectural board
- Airport tenants and user groups
- Economic development agency
- Chamber of commerce
- Other local agencies

3. Adopt a community outreach and public involvement process to be used during the planning activities. This is a very important and ongoing process for some communities when planning GA development that includes a new access road and/or terminal building. Do not wait until the plan is finished to get buy-in from a local community. Involve the community during the planning process. The time to establish this process is during Phase A. This community outreach is the public involvement discussed in Chapter 3 during an airport master plan or ALP update.
4. Review the governing documents and important principles.
5. Inventory of existing facilities—where are we today?

Phase B—Determine Needs

The purpose of this phase is to determine the existing and future GA needs, desired ownership/operation model (e.g., airport owner, FBO, SASO, private individuals, private developers, or a combination) and identify conceptually where facilities might be on the airport (broad indication). Phase B complements several of the airport planning process steps outlined in Chapter 3. A critical step in any plan is to determine needs. Aviation forecasts developed during an airport master plan or ALP update provide indicators of future demand which has a direct correlation to GA planning. Chapter 5 provides more discussion and guidance on how to translate the needs for specific GA facilities into efficient layouts. Specific steps in Phase B include

1. Identify GA forecasts and other activity indicators for the airport. It is important that FAA generally agrees with the forecasts when they drive future federal funding.
2. Determine the desired ownership/operation model. If an area will be developed by an FBO, the FBO will often determine the sizing and layout of the facilities.
3. Determine facility requirements and size/location of each facility (see Chapter 5 for more guidance).
4. Conceptual plan—identify possible areas for various functions. The conceptual plan can vary significantly. Some airports have 'greenfield' opportunities for development. Others are very constrained and various functional areas are well-established. These functional areas might include terminal/aircraft parking, aircraft hangar storage, aircraft servicing (e.g., wash racks and self-fueling), and airport administration/maintenance facilities.

Phase C—Adopt the Plan

1. Identify alternatives for GA facility layouts.
2. Evaluate the alternatives (using principles and considerations discussed earlier in this chapter and Chapter 3).
3. Adopt the plan following a process established in Phase A.
4. Prepare a financial plan for the adopted alternative.

Indicators of Activity that Drive GA Facility Planning

The following activities drive the need for facilities:

- Number and type of existing and forecast based aircraft. The Airplane Design Group and quantity directly affect apron needs, hangar size, and fueling capacity needs.

- Hangar inventory and waiting lists. Waiting lists sometimes can be overly inflated when persons on the list do not have a financial investment involved (e.g., a deposit).
- Tenant interviews.
- Itinerant activity. Talk to corporations in the community to determine their needs. Also, facility needs for itinerant aircraft can be significant for resort areas and large metropolitan areas with major convention facilities.
- Fuel sales.
- Activity at neighboring airports.
- Activity forecasts.
- Existing and planned airfield infrastructure (e.g., runway length).
- Industry trends and forecasts of types of aircraft and ownership models.
- Planned critical aircraft.

CHAPTER 5

GA Facility Planning by Type

This chapter provides detailed guidance on planning and preliminary design of each facility type and will be particularly useful to airport management and consultants as they begin planning the specific layout, sizing, and conceptual floor plans of facilities. Guidance for each facility generally includes the following:

- An introduction, including questions one might ask for the particular facility being planned. The answers to these questions help orient the planner.
- Location and type. Each facility has certain principles the planner should strive to meet regarding the facility's location relative to other facilities on the airport.
- Size. The desired size of each facility and how that is determined is discussed.
- Layout. There are many factors that dictate the specific layout or floor plan of a facility.
- Other Considerations. These may include a facility's relationship to other facilities, security, or considerations specific to the facility being planned.
- Plan Evaluation. This is a brief list of issues for evaluating the plan of a specific facility.

One of the key documents used in the layout of facilities is FAA's AC 150/5300-13A, *Airport Design.* Chapter 5 uses several of the terms from that AC (e.g., Aircraft Design Group, Object Free Area (OFA) and taxiway/taxilane). Appendix A of this Guidebook provides a glossary of terms used throughout the Guidebook, including Chapter 5. Readers not familiar with terms used in this chapter may need to refer to Appendix A.

This chapter provides guidance in planning and developing certain GA facilities. The guidelines presented will not always work in every situation. The Guidebook user should adapt the guidance to specific short-term and long-term airport and facility needs.

Aircraft Aprons

An aircraft apron is usually the largest facility on an airport, except for the runway and possibly the parallel taxiway. An apron requires significant planning because of the short-term and long-term impacts to the airfield and other GA facilities. It is important to pick the right location and size the apron properly so that the apron interacts well with other GA facilities and so that airport operations are not limited and safety is not compromised.

Questions to ask when planning an aircraft apron:

- Is there an airport master plan and what does it say about aircraft aprons?
- Will the apron be for based or transient aircraft or both?
- Will the apron accommodate hangars?
- How many tie-down positions are needed?

- What Airplane Design Group will the apron be designed for?
- Will the apron be planned for a terminal or FBO building?
- Will the apron need to be expanded in the future?
- Are there significant engineering issues such as cut/fill challenges? Drainage challenges?
- Will construction affect other facilities on the airport and how does that affect planning?

Location

An apron location should

- Provide safe and easy ingress and egress for aircraft from taxiways and taxilanes.
- Maximize the available space.
- Provide space for other GA facilities like hangars or a terminal building.
- Provide sufficient parking area outside the required object frees areas and setback requirements.
- Not interfere with the possible expansion or construction of other airfield facilities.
- Provide vehicle access.
- Ensure that pilots and passengers do not have to cross a taxiway to reach their aircraft.

The location of the apron will depend on the size needed and the size of the apron will depend on how much space is available in the proposed location.

Whether planning for an Aircraft Design Group I or Aircraft Design Group II apron, it is recommended that the basis for the apron layout be planned around tie-down positions for Group I aircraft. Given that most Group II aircraft are larger and generally more expensive than Group I aircraft, very few are stored long term on an apron.

Type

Three types of apron are discussed below.

Transient Parking Apron

A transient apron is usually a higher activity, lower density apron where aircraft do not stay very long. These aprons have high turnover with various size aircraft ranging from small single-engine piston to medium-sized business jets.

Based Parking Apron

A based apron is usually a lower activity, higher density apron where aircraft are stored long term. These aprons have low turnover with similar size and type of aircraft, usually small single-engine piston and small twin-engine piston.

Smaller airports usually only have one apron, which is sized to accommodate both transient and based aircraft parking.

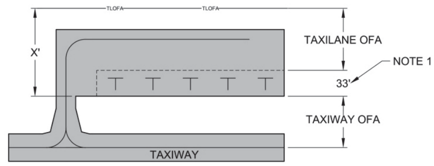
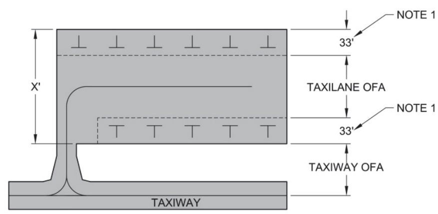
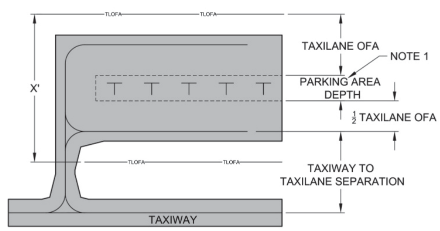
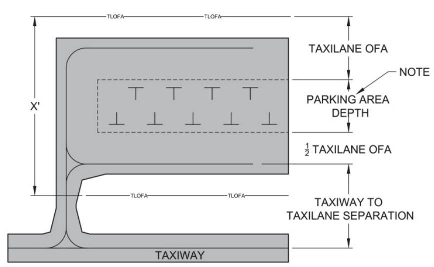
Hangar Apron

A hangar apron is usually only used by aircraft based in the adjacent hangars. (See the conventional hangar section for more on hangar aprons.)

Size & Layout

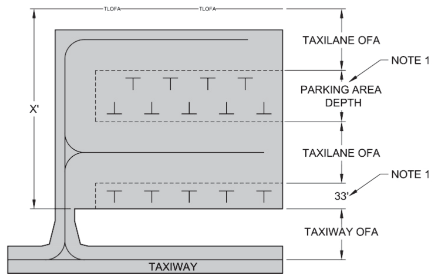
There are two ways to approach the sizing of an apron. One is based on the space available in the location chosen for the apron; the other is based on the number of tie-down parking positions needed. Exhibits 5-1 through 5-8 will help in deciding what size apron can be constructed in the area chosen. Exhibit 5-1 describes the types of aprons based on their depth. Depth Types will be used throughout the planning process with other aspects of the apron. Refer to Appendix B for calculations. This depth is recommended based on the existing and most common tie-down

Exhibit 5-1. Apron depth types.

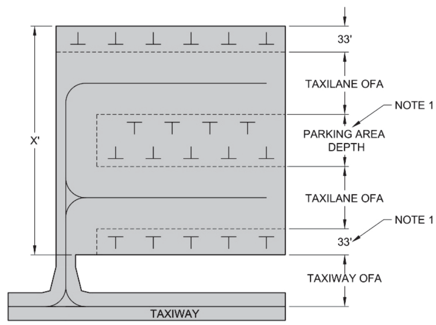
DEPTH TYPE	EXHIBIT	DESCRIPTION
A		Single row of tie-down positions Single taxilane
B[2]		2 single rows of tie-down positions Single taxilane
C		Single row of tie-down positions 2 taxilanes
D		Nested row of tie-down positions 2 taxilanes

(continued on next page)

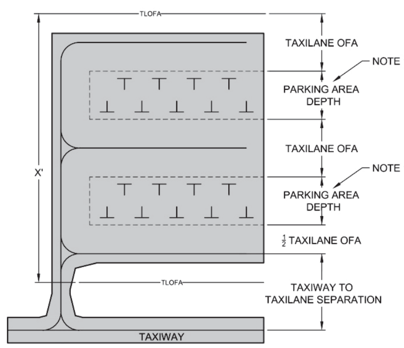
Exhibit 5-1. (Continued).

<table>
<tr><th>DEPTH TYPE</th><th>EXHIBIT</th><th>DESCRIPTION</th></tr>
<tr><td>E</td><td>
</td><td>Single row of tie-down positions

Nested row of tie-down positions

2 taxilanes</td></tr>
<tr><td>F[2]</td><td>
</td><td>2 single rows of tie-down positions

Nested row of tie-down positions

2 taxilanes</td></tr>
<tr><td>G</td><td>
</td><td>2 Nested rows of tie-down positions

3 taxilanes</td></tr>
</table>

Notes: 1. See Appendix B for information on this dimension.
2. Recommended only for based aircraft aprons because of the presence of tie-downs along the edges of the apron.
Source: Delta Airport Consultants, Inc.

configurations in use. The apron sizing guidance in this Guidebook is primarily for Group I and Group II aircraft. Group III aircraft will require special planning and consideration due to the size required to accommodate them.

Exhibit 5-2 presents minimum apron depths based on AC guidelines. As depicted in the figures in Exhibit 5-1, these dimensions do not include any taxiway-to-taxiway separation distances or adjacent taxiway OFAs. For information on the parking area depths, see Appendix B. Exhibits 5-3 and 5-4 present minimum apron widths based on current AC guidelines. The total width includes parking area, taxilanes, and taxilane object free areas (TLOFAs).

The most common layout of an apron is parallel to the runway or parallel taxiway. This orientation usually allows for the maximum use of space. Aprons may also be perpendicular to the runway or taxiway. A guiding principal when planning an apron, or for any facility, is that the most space is usually gained from making the parking areas and taxilanes as parallel or perpendicular as possible to the runway, parallel taxiway, and other facilities. In some cases when the existing infrastructure (e.g., hangars and terminal) are not parallel to the parallel taxiway, a combination of parallel and perpendicular works best.

Exhibit 5-2. Minimum apron depths.

Group I Aircraft Apron depths (66-ft-deep parking area)

Depth Type	Minimum Depth X (ft)
A	112
B	145
C	191
D	224
E	257
F	290
G	369

Example: if an area is selected for a Group I apron adjacent to a taxiway, and there is only 250 feet from the taxiway OFA to a building, there is a not enough depth for Types E, F, and G. Type D is the largest apron depth possible that still meets standards.

Group II Aircraft Apron Depths

(66-ft-deep parking area)

Depth Type	Minimum Depth X (ft)
D	296
E	329
F	362
G	477

(75-ft-deep parking area)

Depth Type	Minimum Depth X (ft)
D	305
E	338
F	371
G	495

(100-ft-deep parking area)

Depth Type	Minimum Depth X (ft)
D	330
E	363
F	396
G	545

Notes: 1. Types A and B are not considered because Group II aircraft will most likely require taxi-through operations and two taxilanes.
2. Type C is not recommended since Type D is a more appropriate size for Group II.

Exhibit 5-3. Minimum apron widths for Group I aircraft.

Single access with deadend taxilanes[1]

DEPTH TYPE	NUMBER OF TIE-DOWN POSITIONS PER GIVEN WIDTH AND DEPTH TYPE				
	223' WIDE	247' WIDE	271' WIDE	295' WIDE	319' WIDE[2]
A	3	3	4	4	5
B	7	7	9	9	11
C	3	3	4	4	5
D	5	6	7	8	9
E	8	9	11	12	14
F	12	13	16	17	20
G	10	12	14	16	18

Single access with taxilanes on all sides[1]

DEPTH TYPE	NUMBER OF TIE-DOWN POSITIONS PER GIVEN WIDTH AND DEPTH TYPE				
	302' WIDE	326' WIDE	350' WIDE	374' WIDE	398' WIDE
A	N/A	N/A	N/A	N/A	N/A
B	N/A	N/A	N/A	N/A	N/A
C	3	3	4	4	5
D	5	6	7	8	9
E	9	10	12	13	15
F	14	15	16	19	22
G	10	12	14	16	18

Dual access with taxilanes on all sides[1]

DEPTH TYPE	NUMBER OF TIE-DOWN POSITIONS PER GIVEN WIDTH AND DEPTH TYPE				
	302' WIDE	326' WIDE	350' WIDE	374' WIDE	398' WIDE
A[3]	3	3	4	4	5
B[3]	8	8	10	10	12
C	3	3	4	4	5
D	5	6	7	8	9
E	8	9	11	12	14
F	13	14	17	18	21
G	10	12	14	16	18

Notes: 1. See Exhibit 5-5 for layout
2. Maximum number of tie-downs recommended for dead end taxilanes
3. Dual access with single taxilane only

For Types A, B, and C, each additional tie-down position requires an additional 48 feet of width.
For Types D, E, F, and G, each additional tie-down position requires an additional 24 feet of width.

The larger an apron, the better access will be required. Multiple access points to an apron are very important for an apron that is very active. However, if at all possible, the apron should be separated from the parallel taxiway as depicted in Exhibit 5-5. Direct access from parking positions onto a parallel taxiway increases the chance of conflicts and should be avoided if possible. Sometimes the limited space available for apron parking may require direct access. Additional marking and signage may be needed to reduce the risk of conflicts as a result of this configuration. The layouts in Exhibit 5-6 illustrate this situation and alternatives to avoid direct access.

The apron layouts in Exhibit 5-5 depict the parking areas parallel to the adjoining taxiway. Exhibit 5-6 lists reasons for choosing how to orient a parking apron. Exhibit 5-7 depicts an apron not deep enough for any Group II apron depths. By turning the taxilanes, a Group II and two Group I parking areas can be accommodated. This layout is best used for based aircraft

Exhibit 5-4. Minimum apron widths for Group II aircraft.

Single Access with deadend taxilanes[3]

DEPTH TYPE	NUMBER OF TIE-DOWN POSITIONS PER GIVEN WIDTH AND DEPTH TYPE				
	283' WIDE	307' WIDE	331' WIDE	355' WIDE	379' WIDE[4]
D	6	7	8	9	10
E	9	11	12	14	15
F	14	16	18	20	22
G	12	14	16	18	20

Single access with taxilanes on all sides[3]

DEPTH TYPE	NUMBER OF TIE-DOWN POSITIONS PER GIVEN WIDTH AND DEPTH TYPE				
	398' WIDE	422' WIDE	446' WIDE	470' WIDE	494' WIDE
D	6	7	8	9	10
E	11	12	14	15	17
F	17	19	21	23	25
G	12	14	16	18	20

Dual access with taxilanes on all sides[3]

DEPTH TYPE	NUMBER OF TIE-DOWN POSITIONS PER GIVEN WIDTH AND DEPTH TYPE				
	398' WIDE	422' WIDE	446' WIDE	470' WIDE	494' WIDE
D	6	7	8	9	10
E	9	11	12	14	15
F	15	18	19	22	23
G	12	14	16	18	20

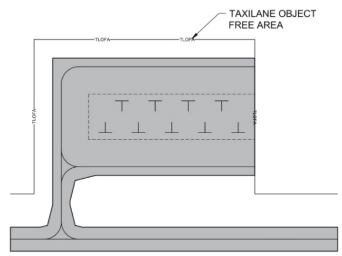
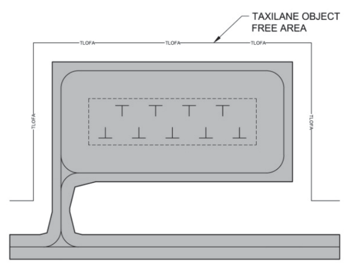
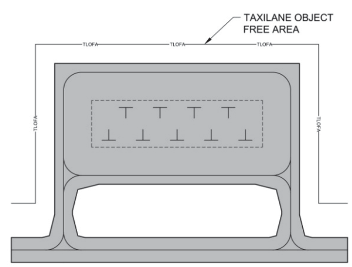
Notes: 1. Types A and B are not considered because Group II aircraft will most likely require taxi-through operations and two taxilanes.
2. Type C is not recommended since Type D is a more appropriate size for Group II.
3. See Exhibit 5-5 for layout.
4. Maximum number of tie-downs recommended for dead end taxilanes

For Types A, B, and C, each additional tie-down position requires an additional 48 feet of width.
For Types D, E, F, and G, each additional tie-down position requires an additional 24 feet of width.

with assigned tie-down locations or FBO aprons where the parking locations can be controlled. The deadend taxilanes could cause issues with pilots unfamiliar with the layout. Extending the deadends to the adjacent taxiway would solve this issue, but multiple entry and exit points off a taxiway could cause safety issues. Significant marking and signing could help to mitigate those issues.

Exhibit 5-8 provides examples of different layouts for the same area near a GA terminal building. The alternative layouts involve relocating the taxiway to the standard separation distance from the runway to achieve greater depth for the apron area. After the taxiway is relocated, the apron can be reconfigured in several different ways. Each layout has its advantages and disadvantages. It will be up to the airport owner or operator to decide which layout best meets the airport's needs. A combination of the angles of the existing infrastructure (e.g., taxiway, runway, and buildings) and making the parking areas and taxilanes parallel and perpendicular will create pavement unusable for taxiing or parking. Anytime infrastructure layouts create odd angles, there will be unusable pavement. The key is to find the layout that minimizes the unusable pavement or positions it in a useful location. Most of the layouts shown in Exhibit 5-8 have unusable pavement in front of hangars or the terminal building. This pavement could be used for parking ground support equipment or aircraft for maintenance or for loading or unloading passengers. In northern regions,

Exhibit 5-5. Apron layout.

Deadend taxilane	
Taxilanes on all sides	
Dual access	

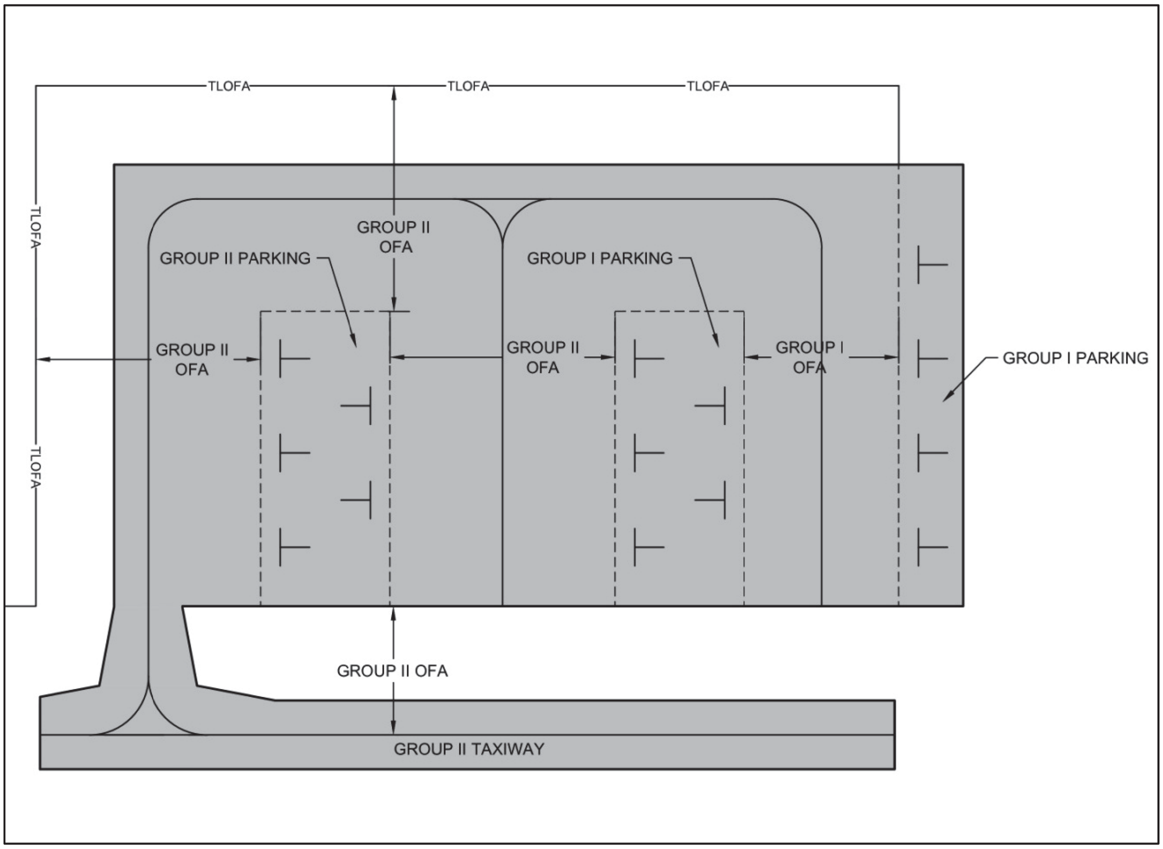
Source: Delta Airport Consultants, Inc.

Exhibit 5-6. Reasons for different layout types.

Parking & Taxilanes Parallel to Taxiway	Parking & Taxilanes Perpendicular to Taxiway
Easy to navigate	Apron is not deep enough for dual taxilanes (Type D)
Simplifies parking	Parking with the prevailing wind direction
Good for unattended aprons	Helps to separate multiple lease areas on the apron Provides the option for multiple sized parking areas

Note: Or parallel and perpendicular to the runway
Source: Delta Airport Consultants, Inc.

Exhibit 5-7. Apron layout perpendicular to taxiway.



Source: Delta Airport Consultants, Inc.

the unusable pavement could be used for snow stockpiling so long as such use does not interfere with aircraft operations and safety.

Security

Other than providing a perimeter fence around the entire airport and apron area lighting, there are no special security recommendations for aprons. The TSA's "Security Guidelines for General Aviation Airports," Information Publication A-001, May 2004, should be consulted when planning this type of facility.

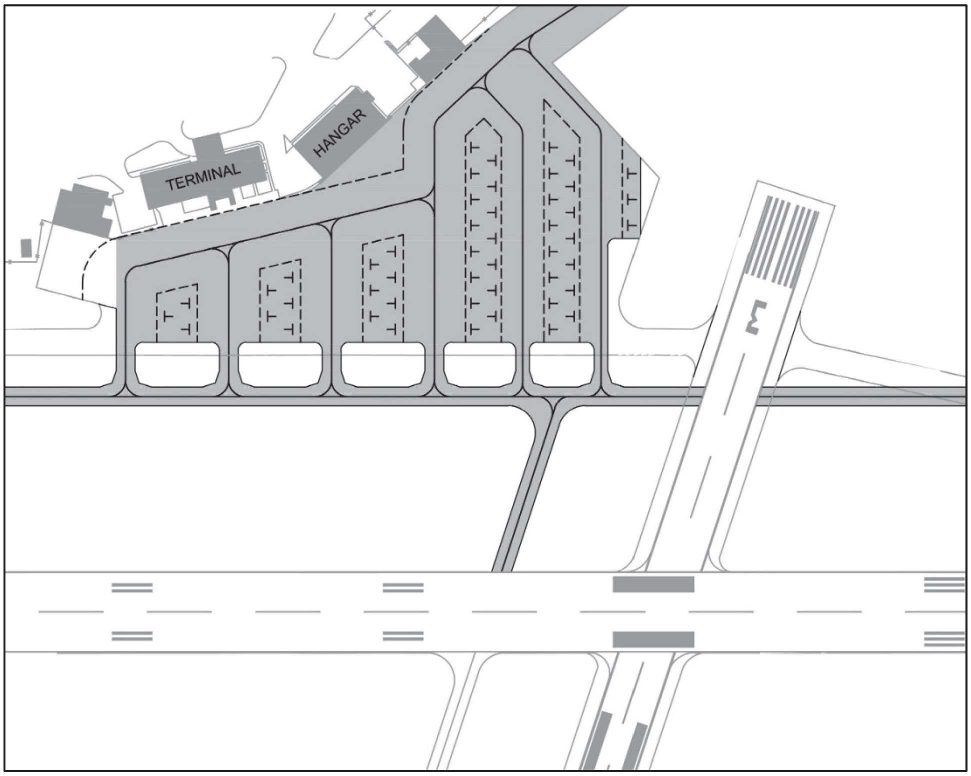
Other Considerations

Engineering and Construction

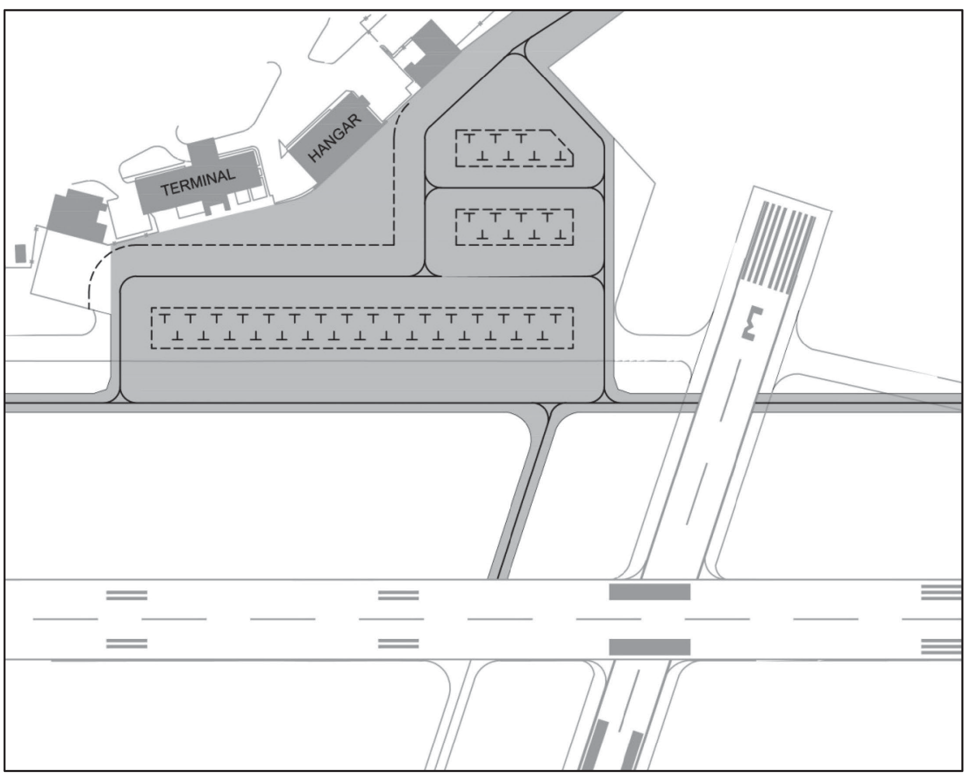
Engineering issues that should be considered follow:

- Stormwater and erosion control measures may require the size of the apron to be adjusted to fit the space available.
- Grades in the area. Do not plan to the property or lease line. Provide adequate buffer for grade tie-ins, grading limits, drainage swales, and storm sewer facilities.
- Apron grades need to be flat enough for aircraft to be tugged or pushed into position but sloping enough to drain.
- Possible need for internal drainage for fuel trapping.
- Construction and phasing impacts on existing facilities.
- Regulations re deicing and possible need for containment and removal.

Exhibit 5-8. Sample apron layouts.

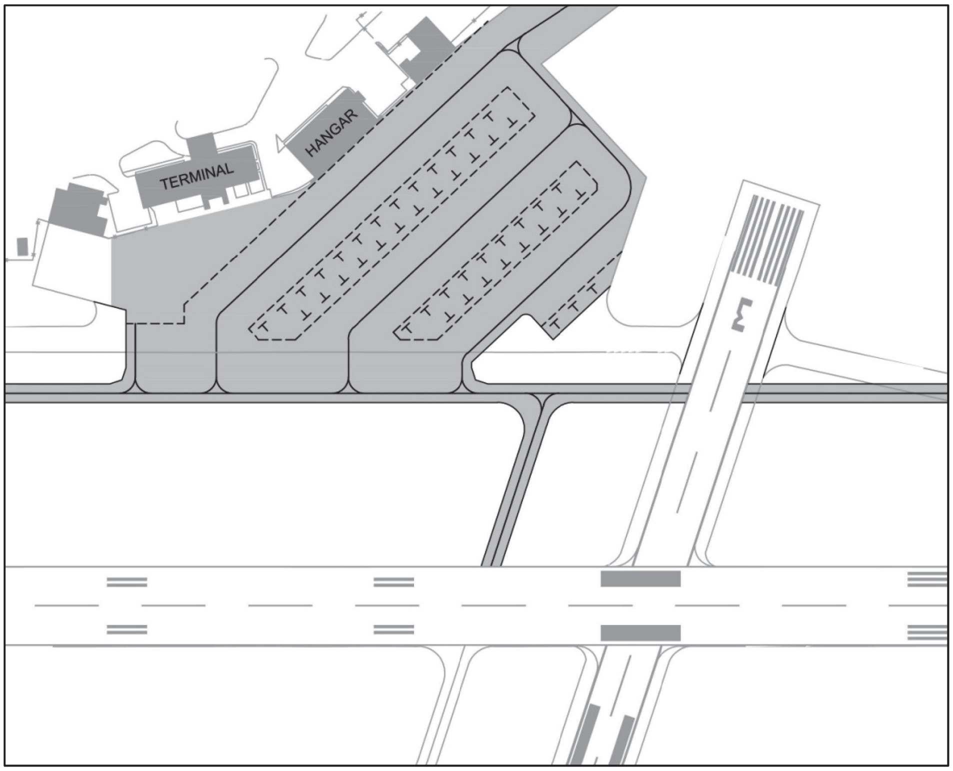


Alternative 1.

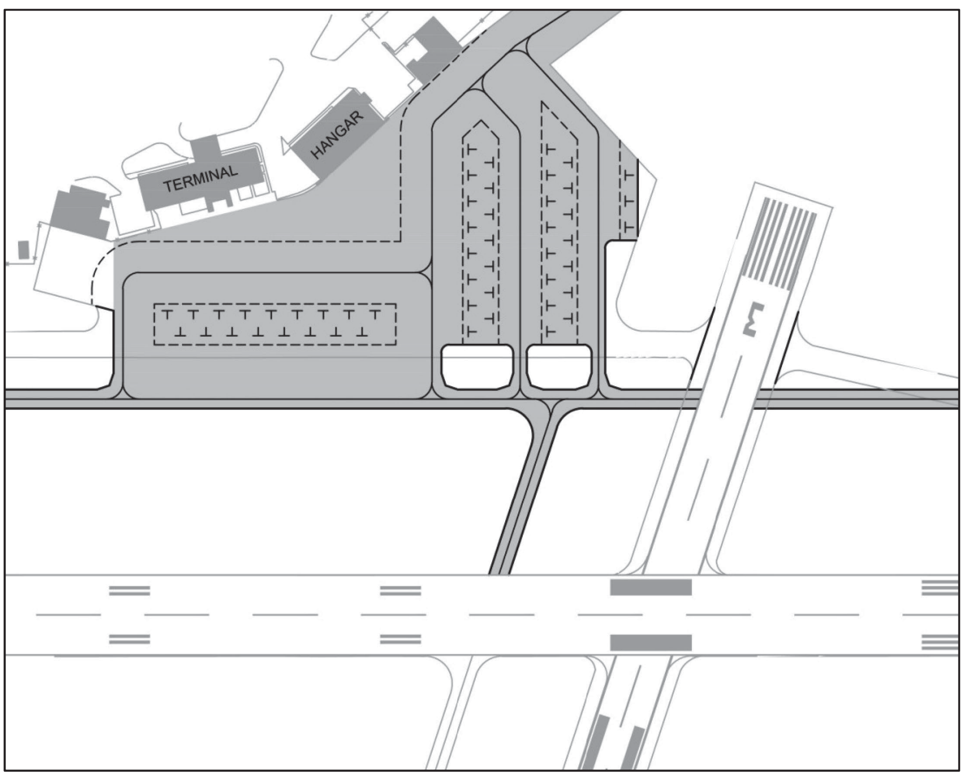


Alternative 2.

Exhibit 5-8. (Continued).



Alternative 3.



Alternative 4.

Source: Delta Airport Consultants, Inc.

Exhibit 5-9. Example of constrained parking apron.

Source: Google Maps, USDA Farm Service Agency

Constricted Aprons

Exhibit 5-9 shows an example of an apron for a Group II airport. The apron provides a Group II taxilane on three sides of the parking positions, but does not provide for Group II parking. If a Group II aircraft were to park in the single row of parking positions, it would violate the taxilane object free areas (TLOFAs) and might have difficulty pulling out because the taxilane between the rows of parking is sized for only Group I aircraft. That same Group II aircraft would have difficulty parking in the nested parking positions because there is no Group II taxilane to access them. If the apron shown in Exhibit 5-7 used the Depth Type E configuration, the same number of tie-down positions could be accommodated with full Group II taxilanes for the nested tie-down positions.

Large GA Aircraft Parking Aprons

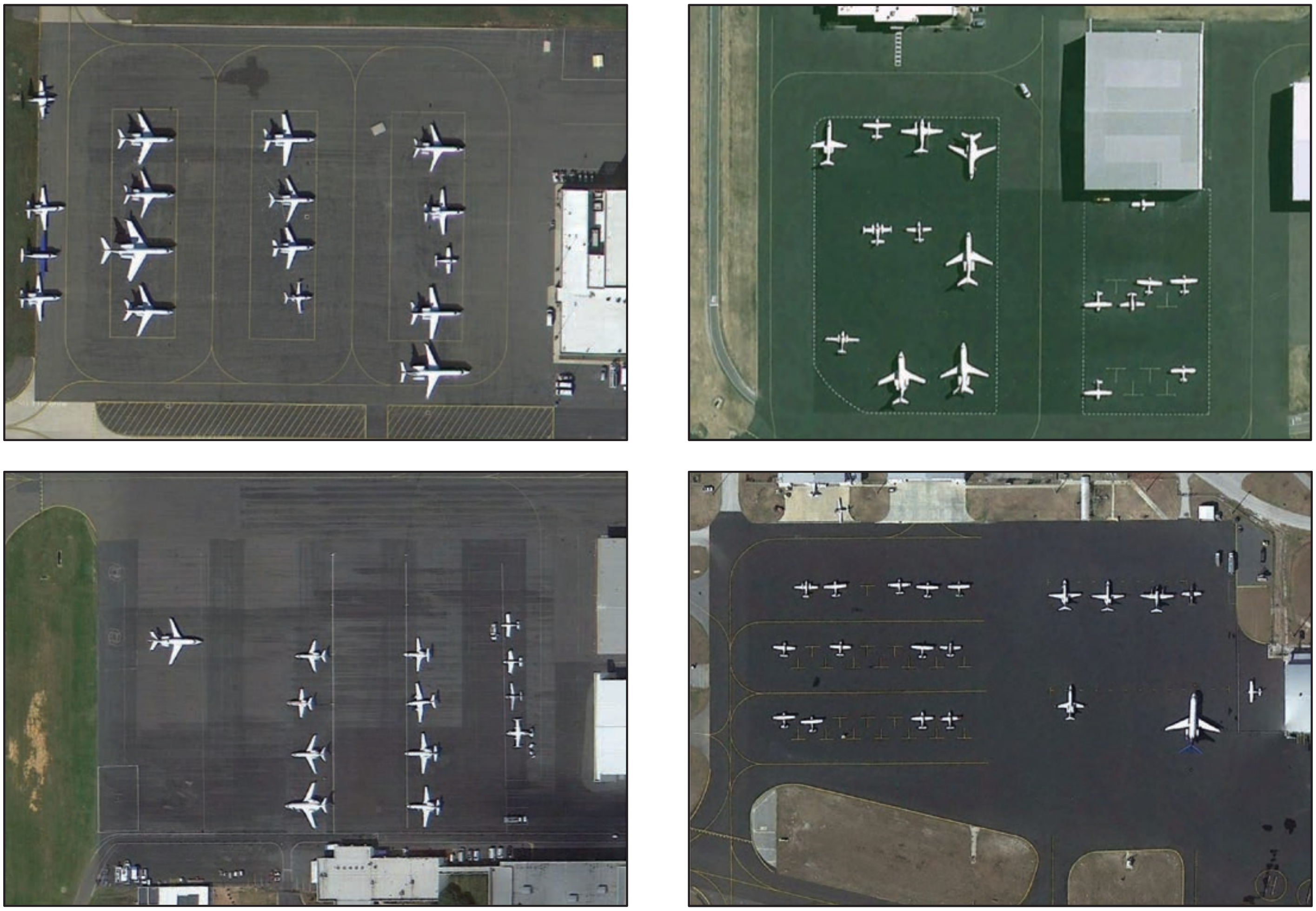
GA aprons at commercial service airports and larger GA airports that serve Group III aircraft and larger will most likely be custom planned. If the apron is managed by a full-time staff that can direct aircraft to parking positions and provide wing walkers, the aircraft can be parked more closely together, thus requiring smaller area per aircraft overall. This also allows them to manage the greater range in the size of the aircraft that use the apron.

Be careful of positioning multiple FBOs on the same apron. This can be very confusing to pilots unfamiliar with the airport and to the FBO staff.

A typical large aircraft parking apron may have rows of parking areas with no tie-down or parking positions marked to allow flexibility for spacing. The only marking may be either a taxilane centerline or the outlines of the parking areas. If smaller aircraft will need to be tied down, these aircraft can be moved to another section of the apron that has tie-down positions for smaller aircraft.

Exhibit 5-10 presents examples of actual FBO GA parking aprons that demonstrate layouts and parking configurations for various sized aircraft without designated parking positions.

Exhibit 5-10. Samples of actual FBO aprons.



Source: Google Maps, USDA Farm Service Agency, Digital Globe, Commonwealth of Virginia

Facility-to-Facility Relationships

The type and number of interaction with other GA facilities depends on the type of apron being planned. A based aircraft apron needs very little interaction with other facilities. A based apron can be a remote facility with only the need for vehicle access and automobile parking. A based aircraft apron would interact well with t-hangars because they both typically store only small aircraft. A transient apron will interact well with many different GA facilities. When planning a transient apron consider whether or not there will be a terminal building, FBO building, or hangars adjacent to the apron that need direct access to the apron. Smaller airports need to consider if there will be a self-service fuel farm facility in the vicinity and ensure that apron operations are not disrupted. (More detail on this interaction and the interaction of dedicated hangar aprons with hangars and automobile parking and access is provided later in this chapter.)

Plan Evaluation

Exhibit 5-11 is a simple checklist to help evaluate the proposed development plan for an aircraft apron.

The Ideal Apron

Transient

The ideal transient apron would include the following characteristics:

- Low density
- Sized for Group II aircraft or larger
- Expandable
- At least two access points
- Full circulation around parking positions
- Ample area lighting
- Pull-through parking positions
- Adjacent to the terminal building
- Passenger boarding area
- Graded for adjacent hangars
- Vehicle access
- Visibility from the runway or parallel taxiway
- Easy egress to the non-secure side of the fence
- Ample parking for several large and small aircraft
- Good drainage
- Ample signage
- Locations for fuel sump dump, chocks, fire extinguisher, and other items
- Parking/storage location for ground support equipment

Based

The ideal based apron would include the following characteristics:

- High density
- Vehicle access
- Sized for Group I aircraft or larger
- Expandable
- Vehicle access
- Nearby vehicle parking with simple walking access
- Good drainage
- Locations for fuel sump dump, chocks, fire extinguisher, and other items

Exhibit 5-11. Aircraft apron development plan evaluation.

Criteria	Yes	No	Comment
Meets the Airport's aircraft parking needs			
Maximizes development space			
Does not interfere with other nearby or future development			
Does not impact or restrict taxilanes or taxiways			
Provides space to meet local engineering requirements (i.e., stormwater and erosion control)			
Interacts well with other facilities			
Provides room for expansion			
Within the project budget			

Helicopter Parking Area

Planning for a helicopter parking area on an airport requires special consideration given the nature of helicopter operations and the impact of rotor wash on the surrounding area. A helicopter parking area is not a helipad. A helipad is used by rotorcraft for takeoff and landing operations. A helicopter parking area is not used for takeoff and landing, but for the temporary parking of helicopters. A dedicated area for helicopter parking is most often used by only transient aircraft. Based helicopter parking is most often in a hangar. For additional information on heliports, see AC 150/5390-2C "Heliport Design."

When planning a helicopter parking area, ask the following:

- Is there an airport master plan and what does it say about a helicopter parking?
- Are there significant engineering issues such as cut/fill challenges? Drainage challenges?
- Will construction affect other facilities on the airport and does that need to factor into planning?
- Will the facility need to be expanded in the future?
- How many helicopter parking spaces are needed?
- What types of helicopters are expected to use the parking area?
- Will vehicles need access to the helicopter parking area?
- Will the helicopter parking area be used by emergency services?
- Is the helicopter parking area for based or transient aircraft or both?

Location

A helicopter parking area location should

- Provide a safe and easy taxiway route to and from the facility.
- Ensure that rotor tips are outside taxiway and TLOFAs.
- Ensure that aircraft or airfield operations (e.g., ARFF) are not impacted.
- Not interfere with the possible expansion or construction of other airfield facilities.
- Avoid rotor wash near small and light aircraft.
- Avoid above ground objects that may interfere with main and tail rotors.
- Provide safe and efficient access for emergency services vehicles.
- Provide fuel tender access to the rotorcraft.
- Allow rotorcraft to park in any direction to account for the wind.
- Be within reasonable proximity to pilot facilities in either a GA terminal building or FBO building.

The location of the helicopter parking area must weigh the benefits of having an area dedicated to a limited type of aircraft and the effect on the surrounding development area versus the effects of not having a dedicated area and mixing fixed-wing and rotorcraft on the same parking apron.

- A good rule of thumb for separation between helicopter parking positions and parked small fixed-wing aircraft (less than 12,500 pounds) is 100 feet. A larger separation may be required for larger helicopters that must air taxi which creates a greater amount of turbulence.
- The Aeronautical Information Manual (dated February 9, 2012) addresses helicopters and fixed-wing aircraft in relation to wake turbulence in Chapter 7, Section 3. It recommends a separation of three rotor diameters.

Size & Layout

The size of the parking area will depend on the size and number of rotorcraft expected. There are two parts to a helicopter parking area: (1) where the rotorcraft parks and (2) the supporting pavement around the parking area. The supporting pavement provides access to the rotorcraft for fuel tenders, emergency services vehicles, and other service vehicles. Exhibit 5-12 depicts a typical helicopter parking area layout.

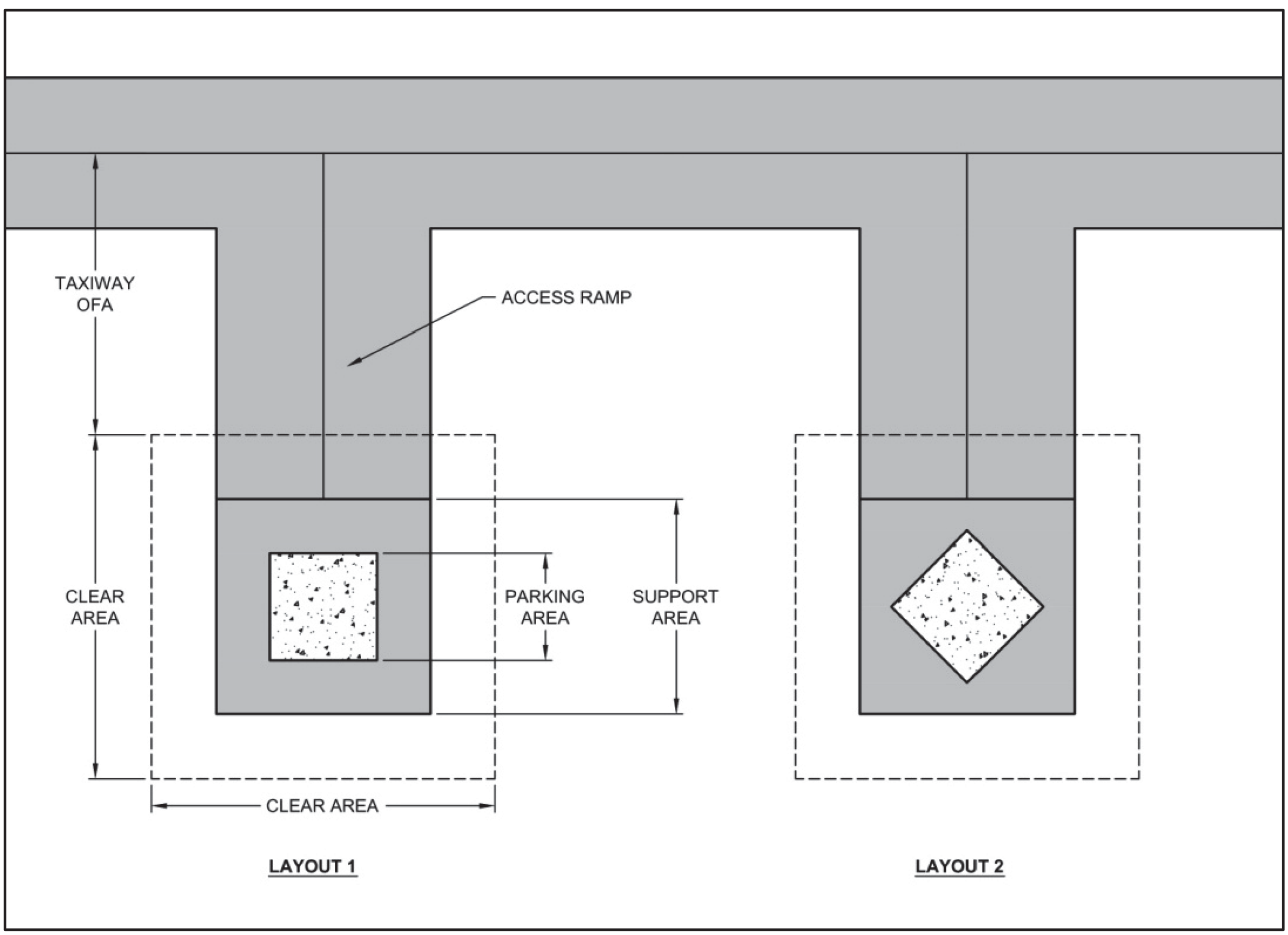
If emergency or support vehicle access is not required, the access ramp leading to the support area can be reduced in width to 25 to 35 feet, depending on the size of the helicopter using the facility.

Exhibit 5-13 presents typical sizes for helicopter parking areas for commonly used rotorcraft.

The helicopter parking areas can be configured in several ways. Exhibit 5-14 depicts sample helicopter parking. Turning the square concrete parking area 45 degrees allows greater flexibility in parking the aircraft by positioning the greatest amount of concrete along the axis of the aircraft in different directions to account for the wind. The area surrounding the concrete parking area can be either concrete or asphalt. If the helicopter parking area is to be used for emergency service operations, sufficient pavement should be provided to allow emergency service vehicles access to all sides of the aircraft.

One of the best methods to maximize development space is to plan facilities to be parallel and perpendicular to each other as much as possible. Angles create unusable space. Making helicopter

Exhibit 5-12. Typical helicopter parking layout.



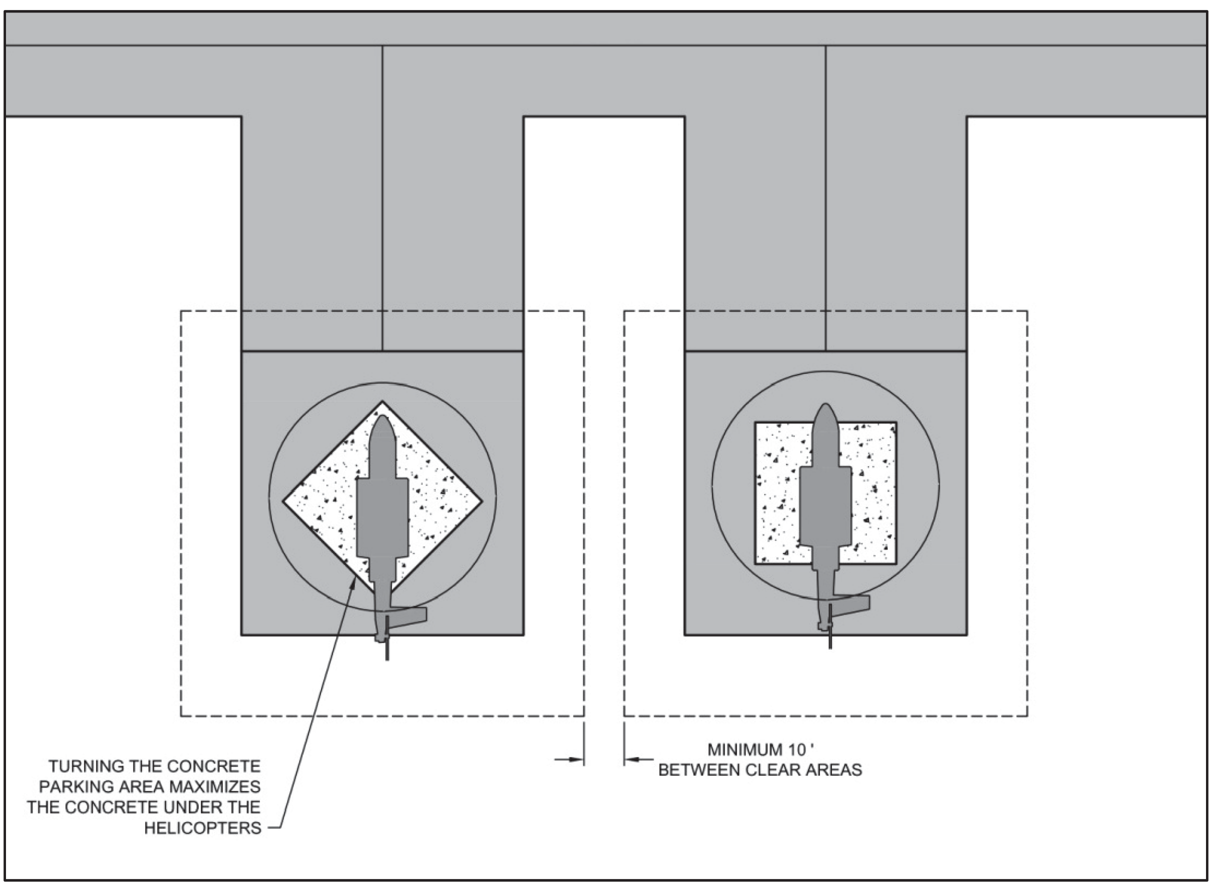
Source: Delta Airport Consultants, Inc.

Exhibit 5-13. Common civilian rotorcraft.

<table>
<tr><th>Helicopter Manufacturer</th><th>Model</th><th>Parking Area (ft)</th><th>Support Area (ft)</th><th>Clear Area (ft)</th></tr>
<tr><td>AgustaWestland</td><td>AW109, AW119</td><td rowspan="5">25 x 25</td><td rowspan="5">50 x 50</td><td rowspan="5">80 x 80</td></tr>
<tr><td>Bell</td><td>47, 206, 407, 212, 222, 427, 429</td></tr>
<tr><td>Eurocopter</td><td>EC120, EC130, EC135, EC145, EC155</td></tr>
<tr><td>MD Helicopters</td><td>MD 500</td></tr>
<tr><td>Robinson</td><td>R22, R44, R66</td></tr>
<tr><td>AgustaWestland</td><td>AW139, AW169, AW189</td><td rowspan="4">35 x 35</td><td rowspan="4">70 x 70</td><td rowspan="4">100 x 100</td></tr>
<tr><td>Bell</td><td>205, 214, 412, 525</td></tr>
<tr><td>Eurocopter</td><td>EC175, EC225</td></tr>
<tr><td>Sikorsky</td><td>S-70, S-76, S-92</td></tr>
</table>

Source: Delta Airport Consultants, Inc.

Exhibit 5-14. Sample helicopter parking.



Source: Delta Airport Consultants, Inc.

parking areas parallel and perpendicular to other facilities and airfield infrastructure also provides for safer traffic flow and expandability.

Security

Given that helicopter parking aprons are within the perimeter fence, there are no special security recommendations. The TSA's "Security Guidelines for General Aviation Airports," Information Publication A-001, May 2004, should be consulted when planning this type of facility.

Other Considerations

Engineering & Construction

Engineering issues to be considered during the planning process:

- Stormwater and erosion control measures that may require the size of the apron to be adjusted to fit the space available
- Grades in the area. Do not plan up to the property or lease line. Provide adequate buffer for grade tie-ins, grading limits, drainage swales, and storm sewer facilities
- Apron grades need to be flat enough for aircraft to be tugged but sloping enough to drain
- Whether or not internal drainage for fuel trapping will be required
- The construction and phasing impacts on existing facilities

Facility-to-Facility Relationships

Not many other GA facilities interact well with helicopter parking areas due to the nature of helicopter operations and the effect of rotor wash on the surrounding area. They should not be close to hangars or other buildings but should be within a reasonable distance of a terminal or FBO building. If the helicopter aprons are to be used by emergency service vehicles, good ground access is important.

The Ideal Helicopter Parking Area

The ideal helicopter parking area would include the following characteristics:

- A concrete parking area
- A paved support area on all sides
- Edge lighting
- Located a safe distance from small and light aircraft
- Located such that additional positions may be constructed
- Located within reasonable distance to pilot facilities
- Configured for parking in different directions
- Located outside taxiway and TLOFAs
- Clear of future development opportunities
- Located reasonably close to vehicle access point

Plan Evaluation

Exhibit 5-15 is a simple checklist to help evaluate the proposed development plan for a helicopter parking area.

Exhibit 5-15. Helicopter parking area development plan evaluation.

Criteria	Yes	No	Comment
Meets the airport's needs			
Maximizes development space			
Does not interfere with other nearby or future development			
Does not impact or restrict taxilanes or taxiways			
Meets FAA design criteria			
Provides space to meet local engineering requirements (i.e., stormwater and erosion control)			
Interacts well with other facilities			
Provides room for expansion			
Within the project budget			

Conventional Aircraft Hangars

The most effective hangar planning also includes apron planning, access planning, and automobile parking planning. There will be considerable cross-over with these other facilities because they are so interconnected. Conventional hangars are expensive and require considerable planning because of the impacts to the airfield and other GA facilities. It is important to pick the right location, size, and type of hangars so that they interact well with other GA facilities and to maximize development space.

When planning for a hangar or group of hangars, ask

- Is there an airport master plan and what does it say about hangars?
- Can associated facilities (e.g., access road, auto parking, and apron) be developed in balance with the hangar?
- Will there be an architectural theme and how will that affect layout, size, and location?
- Are there significant engineering issues (e.g., cut/fill challenges)? Drainage challenges?
- Are there existing and planned utilities to meet building needs?
- What are community goals and standards that will affect the building plans?
- Will construction affect other facilities on the airport and does that need to be factored into planning?
- Will the building need to be expanded in the future?
- What types of hangars are needed?
- What sizes of hangars are needed?
- Are different size hangars needed?
- How much developable space is available?
- Is there room for infill or is greenfield development required?
- Is space needed for office or workshop space attached to the hangar?
- Do the hangars have to interact with other facilities or can they be remote?
- Will the hangar need airside and landside access?

Location & Orientation

A hangar location should

- Provide enough space to park the largest aircraft that can fit in the hangar outside the hangar and be clear of all OFAs.
- Not present an obstructed view to or from the terminal building or an FBO building.
- Ensure that employees do not have to cross active airfield pavements to reach the facility.
- Not interfere with the possible expansion or construction of other airfield facilities.
- Meet AC 150/5300-13A and FAR Part 77 guidelines.
- Maximize the space available and not restrict additional development around it.

- Be near utilities needed for office or shop areas.
- Be with similar sized hangars.
- Ensure that vehicle access and parking space is available.

A hangar should be oriented so that

- In regions that have ice and snow, doors do not face north blocking the apron in front of the door from the sun.
- In hot and sunny regions, doors do not face south so that the inside of the hangar does not receive direct sunlight in the afternoons heating up the hangar. This is especially important in maintenance hangars not conditioned with cool air.
- The primary wind direction is not into the hangar.

These location and orientation objectives cannot always be met given the orientation of the runway, existing airfield infrastructure, and the need to maximize development space.

Type & Size

Storage Hangar

A storage hangar typically consists of three walls, a roof, and a large door and serves to keep parked aircraft out of the elements. If other functions take place in the hangar, it is probably another type of hangar.

Storage hangars can be built to whatever size is needed; however, some hangar sizes are more common than others. Exhibit 5-16 provides information for several common hangar sizes and door heights to accommodate a single aircraft. For instance, a 70-ft-by-70-ft hangar with a 20-ft-high door opening will accommodate approximately 70% of the current GA fleet.

If the hangar is to be used for only one aircraft, the size of the hangar needs to be planned using the wingspan and length of that aircraft. A good rule of thumb to determine the width of the hangar is to add 10 feet to the wingspan of the design aircraft. The 10 feet provides room for the door infrastructure and a buffer between the wings and the door. For example, the Hawker 850 has a wingspan of 54 feet. With the 10-ft addition, the Hawker 850 requires a minimum 64-ft wide hangar. The same rule of thumb applies to determining the depth of the hangar. The 10 ft rule of thumb may not work for all cases and, if a particular aircraft is in mind for the hangar, the 10 feet may be reduced. For the door height, allow a buffer of at least 1 foot between the top of the tail and the door opening.

Given that hangar tenants come and go, make sure the hangar size provides flexibility for future tenants and the airport.

The larger the hangar, the more flexibility there is with the types and number of aircraft that can be stored in that hangar. A 100-ft-by-100-ft hangar may store one Gulfstream IV, four King Air 100s, or eight Beech Baron 58s. The use of the hangar will help determine what size is needed. If the hangar is to be a community storage hangar with multiple tenants, a bigger hangar will provide more flexibility. The downside to a community hangar is that if someone wants their aircraft and it is in the back, other aircraft will have to be moved first. This type of hangar works well when there is a FBO or aircraft manager in charge of the hangar.

Exhibit 5-16. Typical hangar sizes (Group I & II aircraft).

Hangar Size	Square Footage	Door Height	% of fleet	Sample Aircraft
60 x 60	3,600	16 feet	~28	Citation CJ2
70 x 70	4,900	20 feet	~70	Hawker 850
80 x 80	6,400	24 feet	~84	Falcon 50
100 x 100	10,000	26 feet	~98	Gulfstream GIV
120 x 120	14,400	26 feet	~98	Gulfstream GIV

Source: Delta Airport Consultants, Inc.

Maintenance Hangar

A maintenance hangar can serve as a storage hangar and as a hangar for conducting maintenance on aircraft. Sizing a maintenance hangar depends on the size of aircraft and the type of maintenance to be performed. The hangar should be sized to handle multiple aircraft at once. A heavy maintenance hangar will require more space per aircraft due to the tasks involved. An avionics hangar will require less space per aircraft. A maintenance hangar will also require space for tools, equipment storage, parts storage, offices, restrooms, and breakrooms. These spaces can be either constructed within the footprint of the hangar or as an external addition to the hangar.

The amount of additional work space needed will depend on the function of the space. This space can either be an integral part of the hangar or constructed as an addition to the hangar. A typical external addition would be 25 feet to 30 feet along the length of the hangar. This space could be added to either the side of the hangar, the back, or both if the space is needed. The amount of space needed will depend on the needs and function of the hangar.

Corporate Hangar

A corporate hangar is usually a storage hangar with office space. The office space can be constructed as an integral part of the hangar or as an addition to the sides or back of the hangar. The additional space may include an office, restroom, conference room, break room, storage, and a lobby area. The size will depend on what type and how many aircraft are to be stored.

Paint Hangar

The only difference between maintenance hangars and paint hangars is that a paint hangar usually has to meet different building code requirements regardless of size. This type of hangar will usually require sprinkler and/or foam deluge systems. See National Fire Protection Association (NFPA) 409 for additional information.

Executive Hangar

When a conventional box hangar is too big and a t-hangar too small, an executive hangar can be a good compromise. An executive hangar is a single structure divided into multiple units sized to accommodate large multi-engine piston and turboprop aircraft as well as small to mid-size jets. Each unit will usually range between 2,500 and 4,000 square feet. An executive hangar usually consists of two to six units. Exhibit 5-17 depicts a typical executive hangar with parking apron.

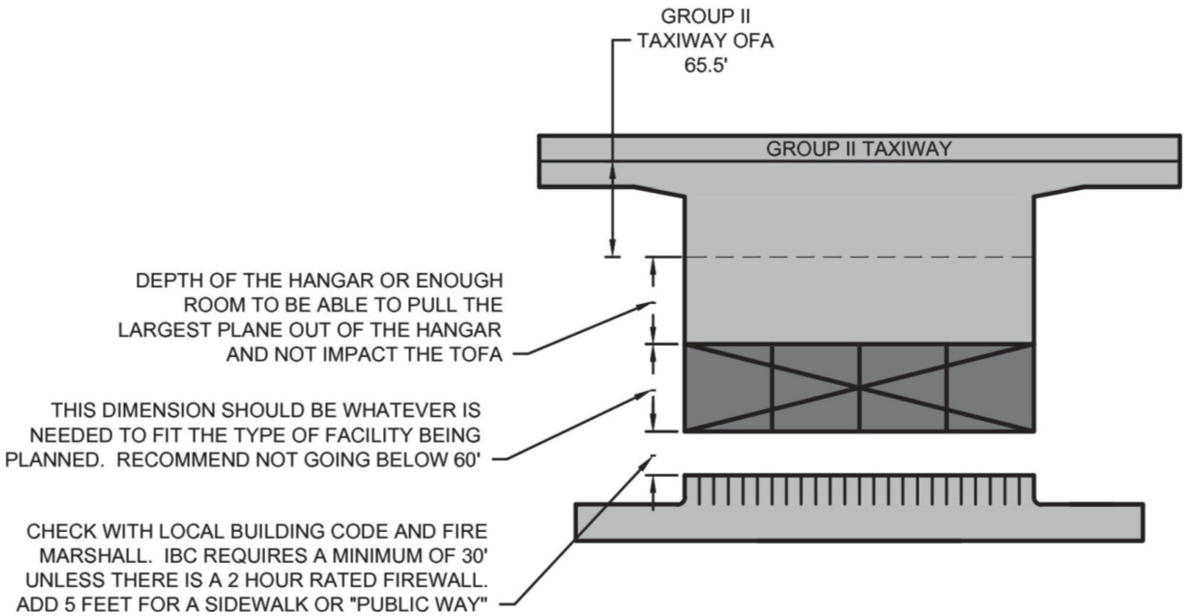
Executive hangars provide flexibility for an airport that does not need the hangar space to accommodate a large aircraft, but needs to house aircraft too large for a standard t-hangar. Adding bathrooms and a small office space will make the hangars more marketable to corporations and businesses. An 18-ft-high door opening will provide additional flexibility. These hangars can be custom sized; however, several hangar manufacturers have standard sizes for these types of hangars. Similar to a t-hangar, executive hangars can be expanded.

Executive hangars can be almost anywhere a conventional hangar or a t-hangar (which will be covered in the next section) can be located. Executive hangars tend to fit better with t-hangars because of the size of the aircraft and the tendency to house multiple smaller aircraft that could fit in a t-hangar. It is very important to make certain that the properly sized taxilane or taxiway is available for the Airplane Design Group II aircraft that can fit in the executive hangars. Although not required, allowing space for aircraft to park outside the hangar and outside a taxiway or TLOFA increases the safety and marketability of the hangar facility.

Non-Hangar Space

If the hangar is to be used for corporate, charter, or FBO purposes, office space may need to be provided. This space can either be an integral part of the hangar or constructed as an addition

Exhibit 5-17. Executive hangar with apron.



Source: Delta Airport Consultants, Inc.

to the exterior of the hangar. A typical external addition would be a 25- to 30-ft wide addition to the length of the hangar. This space could be added to either the side of the hangar, the back, or both if the space is needed. The amount of space needed and the functions of the space will depend on the function of the hangar and the needs of the tenants.

Building Codes and Hangar Spacing

Federal, state, and local building codes play an important part in determining the location and size of hangars. Most states have adopted the International Building Code (IBC) and International Fire Code (IFC) for building construction. Both documents include requirements for aircraft hangars. It is important to review the local codes and meet with the local fire marshal and building code office to determine what guidelines are to be followed and how the local officials interpret the codes. How the codes are interpreted can have a significant impact on how the hangars are planned.

There are numerous combinations of hangars based on size, type of construction, and hangar group (not to be confused with FAA Aircraft Design Groups). For this Guidebook, the most common type will be discussed. The most common classification of hangar is a Hangar Group III with Type II (000) construction. The (000) means there is no fire rating to the exterior walls, structure, and floor. A Hangar Group III hangar is one floor, has a door height of 28 feet or less, Type II (000) construction, and a maximum fire (floor) area of 12,000 sf. If the fire area is larger than 12,000 sf, additional fire protection will be required, either through the use of fire-resistant building materials or a sprinkler system or both.

Spacing

Common planning dimensions to use based on the IBC and IFC are 50 feet between hangars and/or other buildings and 30 feet between hangars and roads/parking lots. Hangars can be closer than 50 feet to each other and other buildings if other construction conditions (e.g., a firewall or fire-resistant building materials) are met. These conditions are in NFPA 409, "Standard of Aircraft Hangars." During the planning for the hangar, the separation requirement should be discussed and a decision made on what spacing to use. A 50-ft separation will take up the most apron frontage, but will probably result in a less expensive hangar. Reducing the separation may allow room for additional hangars, but the hangars may be more expensive due to the additional construction costs from fire protection measures. Depending on the demand, the extra cost for the fire protection measures may reduce the marketability of the hangar site.

If planning a hangar with sliding pocket doors, take into account the pocket or supports needed for the sliding door panels. Other door options are available, including bi-fold and hydraulic. Neither of these requires any additional space outside the footprint of the hangar. If there are pockets or supports outside the footprint of the hangar, the local fire marshal may deem them part of the hangar and require the 50 foot separation from them or 2-hr rated firewall for the pocket or support.

Exhibit 5-18 provides simple guides for hangar spacing examples and guidelines. Also consult local codes for building setbacks from property lines, lease lines, and roadways. The IBC also has instructions for building setbacks.

Layout

One of the best ways to maximize development space is to plan facilities to be parallel and/or perpendicular to each other as much as possible. Angles create unusable space. Making hangars parallel and perpendicular to other facilities and airfield infrastructure also provides for safer traffic flow and expandability. Exhibit 5-19 provides possible layout spacing.

Exhibit 5-18. Simplified planning guide for NFPA Group III aircraft hangars.[1]

No. of Hangars	Size (ft)	Total Square Footage	Distance to nearest hangar	Fire Protection	Minimum Distance to other building (Terminal) or hangar	Minimum Distance to parking and roads
1	all single hangar sizes up to	12,000	at least 50'	no fire protection	50' on all sides	30'
1+	multiple hangars up to	24,000	at least 50'	no fire protection	50' on all sides of each hangar	30'
1+	multiple hangars up to	24,000	less than 50'	no fire protection	100' on all sides of hangar group	30'
2	120 x 120	24,000	at least 50'	no fire protection	50' on all sides of each hangar	30'
2	120 x 120	24,000	less than 50'	no fire protection	100' on all sides of hangar group	30'
2	120 x 120	24,000	less than 50'	with fire protection	100' on all sides of hangar group	30'
3	120 x 120	36,000	less than 50'	Select hangar is considered a Group II Hangar and must have fire protection	see NFPA 409 for Group II guidance	30'

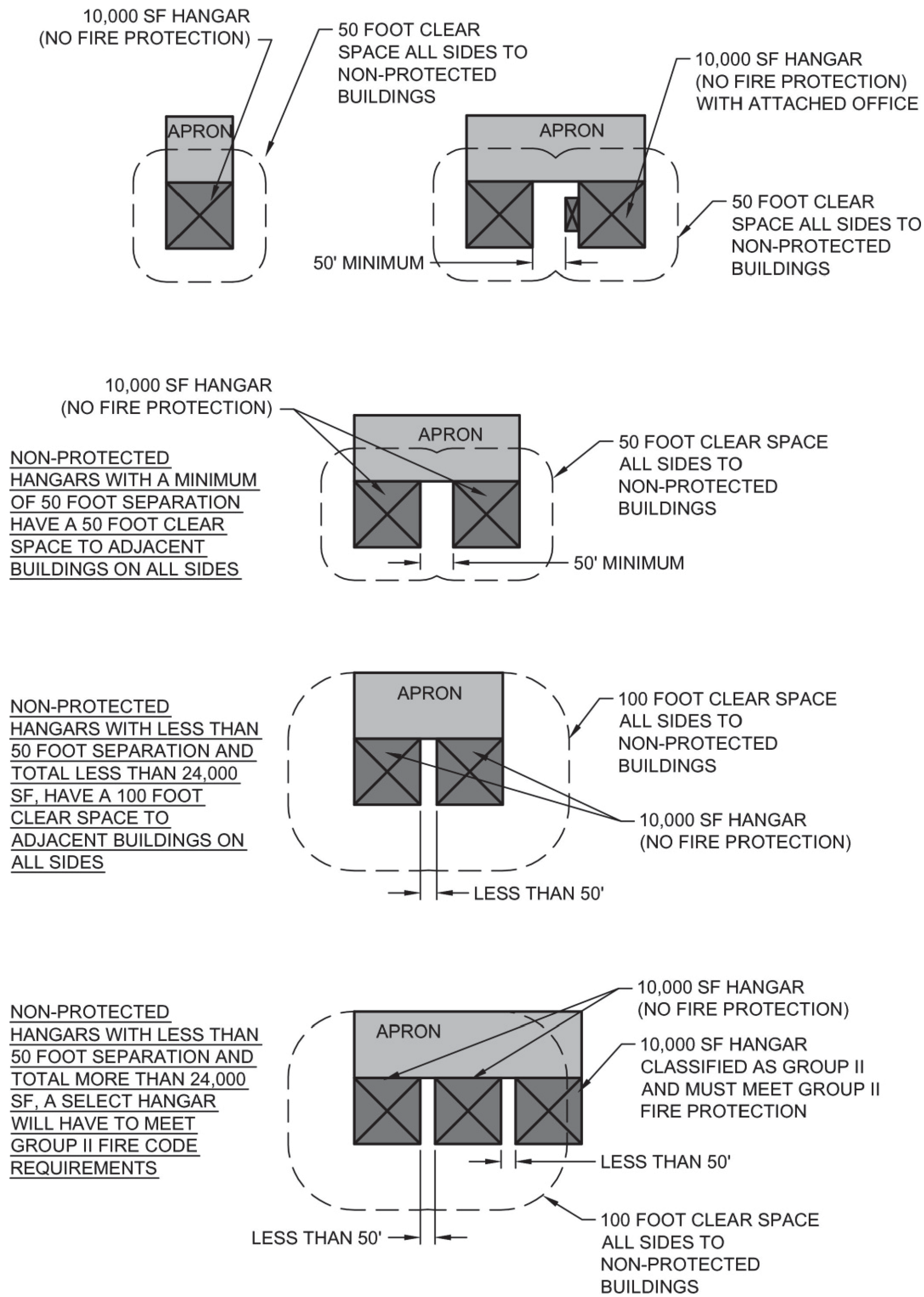
(continued on next page)

Exhibit 5-18. (Continued).

No. of Hangars	Size (ft)	Total Square Footage	Distance to nearest hangar	Fire Protection	Minimum Distance to other building (Terminal) or hangar	Minimum Distance to parking and roads
2	100 x 100	20,000	at least 50'	no fire protection	50' on all sides of each hangar	30'
2	100 x 100	20,000	less than 50'	no fire protection	100' on all sides of hangar group	30'
2	100 x 100	20,000	less than 50'	with fire protection	100' on all sides of hangar group	30'
3	100 x 100	30,000	less than 50'	Select hangar is considered a Group II Hangar and must have fire protection	see NFPA 409 for Group II guidance	30'
2	80 x 80	12,800	at least 50'	no fire protection	50' on all sides of each hangar	30'
2	80 x 80	12,800	less than 50'	no fire protection	100' on all sides of hangar group	30'
3	80 x 80	19,200	less than 50'	no fire protection	100' on all sides of hangar group	30'
4	80 x 80	25,600	less than 50'	Select hangar is considered a Group II Hangar and must have fire protection	see NFPA 409 for Group II guidance	30'
2	60 x 60	7,200	at least 50'	no fire protection	50' on all sides of each hangar	30'
2	60 x 60	7,200	less than 50'	no fire protection	100' on all sides of hangar group	30'
3	60 x 60	10,800	less than 50'	no fire protection	100' on all sides of hangar group	30'
6	60 x 60	21,600	less than 50'	no fire protection	100' on all sides of hangar group	30'
7	60 x 60	25,200	less than 50'	Select hangar is considered a Group II Hangar and must have fire protection	see NFPA 409 for Group II guidance	30'

[1]Type of Construction: Type II (000)
Source: NFPA 409

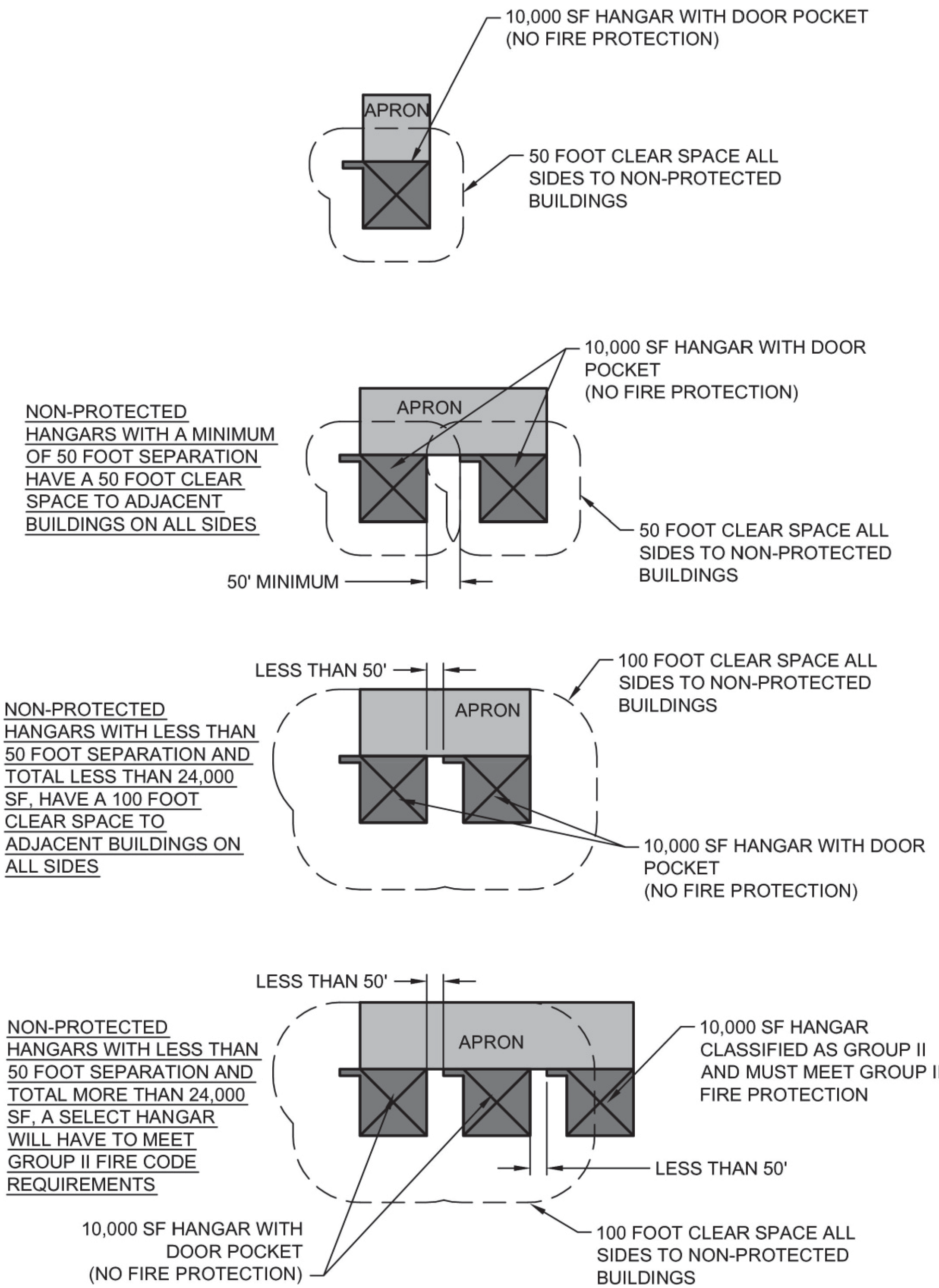
Exhibit 5-19. Examples of possible layout spacing.



Hangar Group III Box Hangar Spacing.

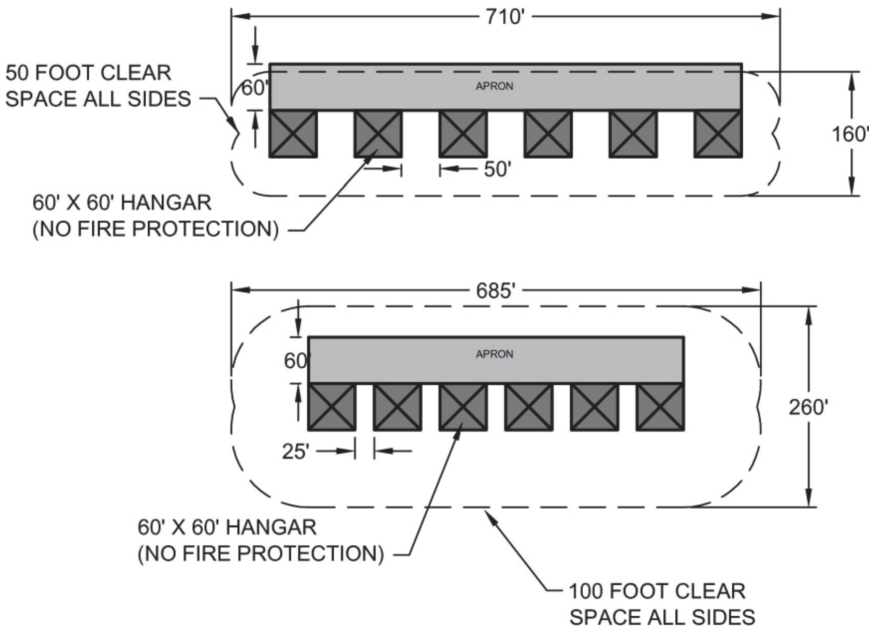
(continued on next page)

Exhibit 5-19. (Continued).



Hangar Group III Box Hangar Spacing with Door Pocket.

Exhibit 5-19. (Continued).



Hangar Group III Small Box Hangar Spacing

Note: Group III refers to the hangar group from NFPA
Source: Delta Airport Consultants, Inc.

Security

Recommendations for basic security measures for a conventional hangar include tamperproof locks on all doors and enough lighting on all sides of the hangar to sufficiently illuminate the area. Additional and more expensive measures would include a monitored alarm system with cameras. If the building is part of the security perimeter, appropriate airside access security measures will need to be incorporated into the building. The TSA guidelines on security for GA airports can be found in "Security Guidelines for General Aviation Airports," Information Publication A-001, May 2004. It is recommended that these guidelines be consulted when planning this type of facility.

Other Considerations

Hangar Apron

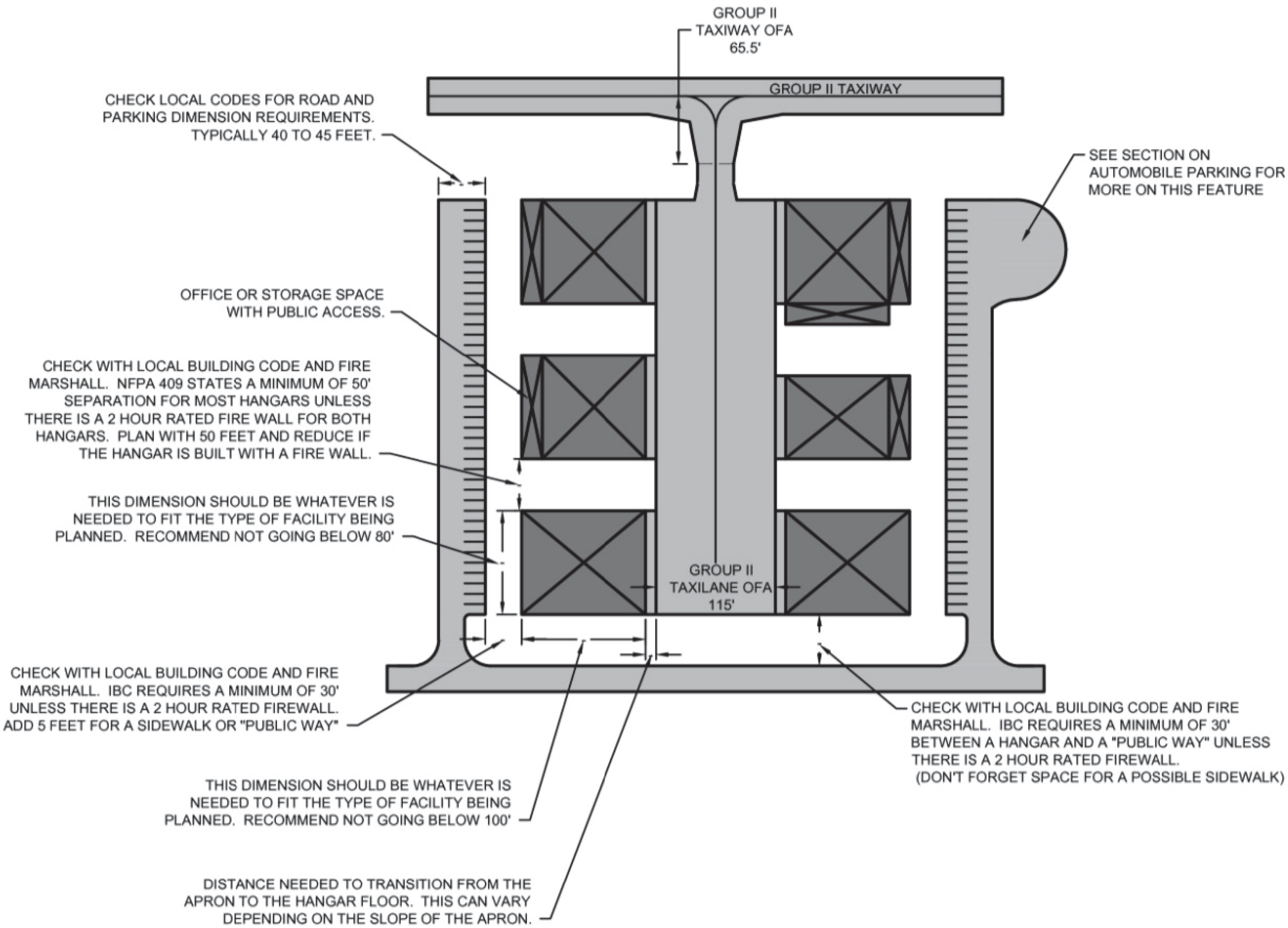
A hangar apron is an apron which provides access to conventional hangars. A hangar apron can be a large area for multiple hangars or a small area for a single hangar. Hangar aprons allow for variable size hangars and associated infrastructure. Exhibit 5-20 shows sample layouts of different hangar apron configurations.

The figures in Exhibit 5-20 depict hangars parallel to one another. Hangars perpendicular to one another are not shown due to their less economical and operational features. There is a greater chance of conflict between aircraft in front of adjacent hangars, and there tends to be either a loss of revenue-generating space or limited access. Perpendicular hangars would work best when the hangars are owned and operated by the same entity so as to control aircraft conflicts and use of space. Although perpendicular hangars are possible, they are not recommended for the previously mentioned reasons. If perpendicular hangars are proposed, ensure adequate separation is provided to reduce the chance of conflict.

Utilities

Hangars having office or shop space will require access to water and sewer connections. This may dictate the locations of the hangars and will affect the budget.

Exhibit 5-20. Sample layouts of different hangar apron configurations.



Hangar Apron Pod with no Aircraft Parking

Note: This configuration is not recommended for facilities expected to provide services (e.g., maintenance, charter, and instruction)

(continued on next page)

Engineering & Construction

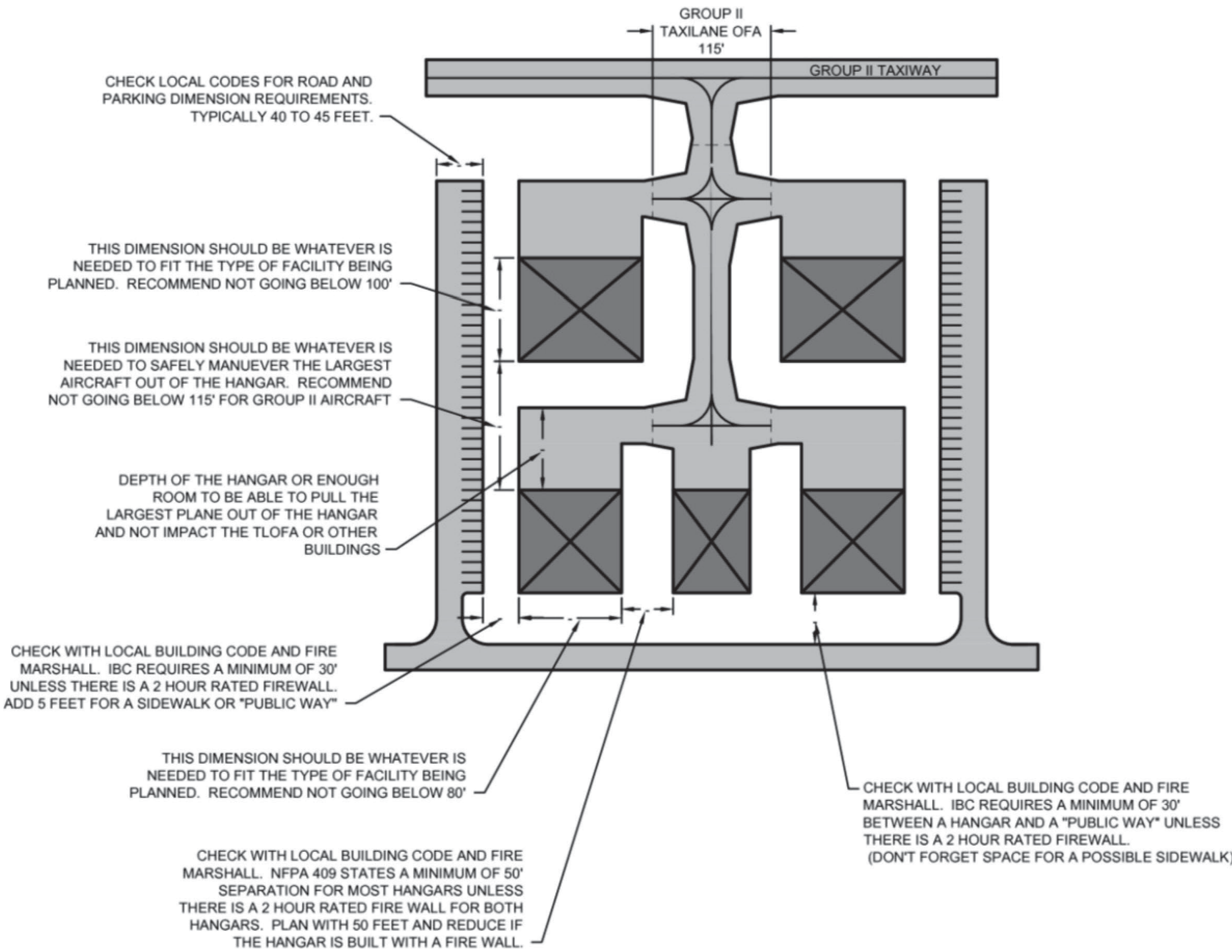
Engineering issues that should be considered include

- Stormwater and erosion control measures may require the size of the apron to be adjusted to fit the space available.
- Grades in the area. Do not plan to construct up to the property or lease line. Provide adequate buffer for grade tie-ins, grading limits, drainage swales, and storm sewer facilities.
- The locations of security fence and gates.
- Grading limitations due to the flat finished floor of the larger buildings.
- The construction and phasing impact on existing facilities.

Facility-to-Facility Relationships

Conventional hangars interact with many other types of facilities (e.g., aprons, automobile parking, and automobile access). Conventional hangars may also interact with a GA terminal building or FBO building as either an attached facility or adjacent facility. As much as possible, conventional hangars of similar size should be planned together. If sizes vary, group the smaller

Exhibit 5-20. (Continued).



Alternate Hangar Apron Pod with Limited Aircraft Parking

Notes: 1. This configuration should only be used when environmental conditions (sun, snow, wind) dictate hangar orientation
2. This configuration is not recommended for facilities expected to provide services (e.g., maintenance, charter, and instruction)

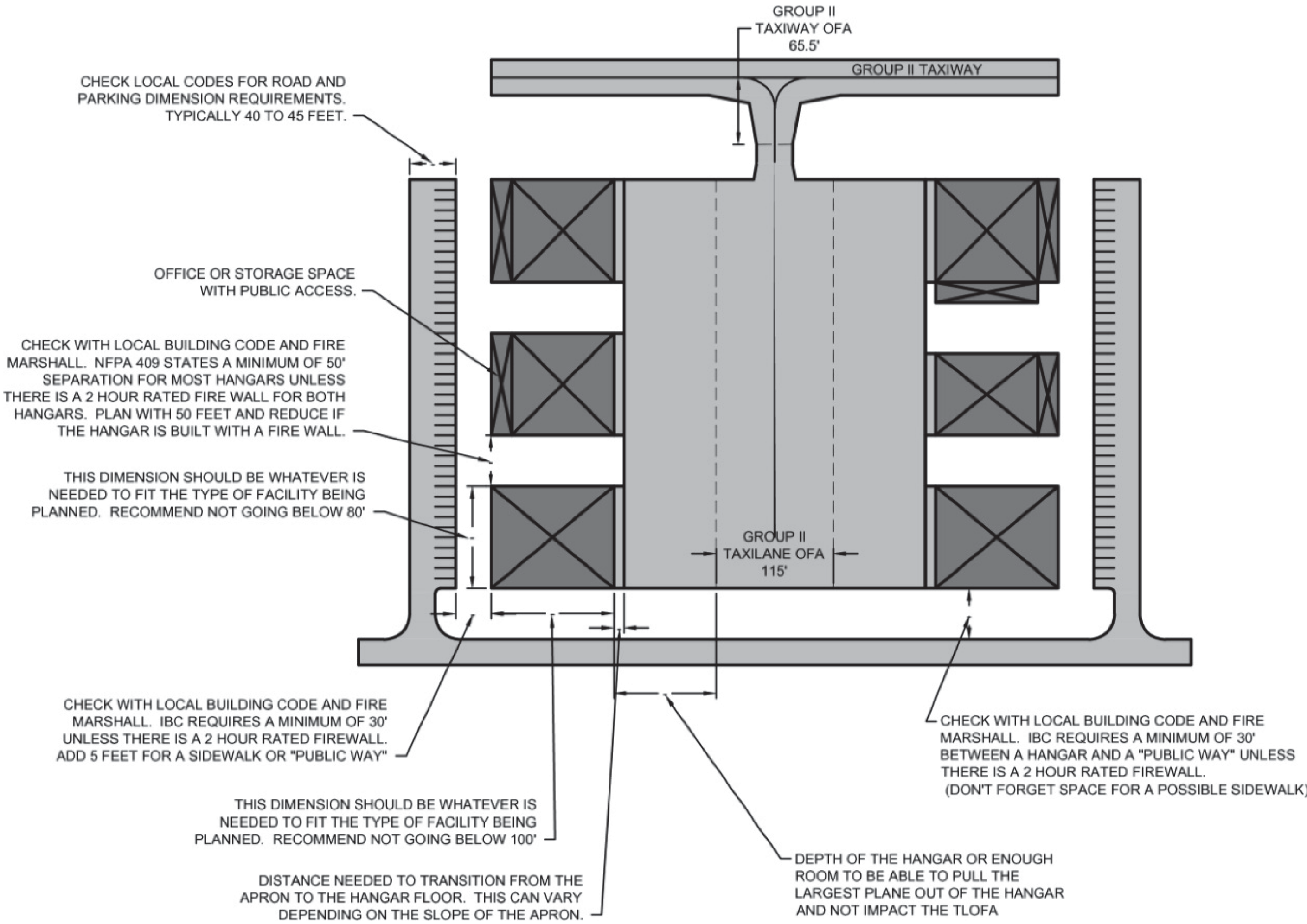
(continued on next page)

hangars together separate from the larger hangars. The larger hangars have a larger building footprint, and the apron parking areas, taxilanes, and automobile parking space requirements are also larger. Executive hangars and smaller box hangars interact well with each other and can often be remote areas similar to t-hangars. Place the right size hangar on a large or main apron. A smaller conventional hangar (60′ × 60′) should not be next to a terminal or FBO building. This space should be reserved for a large storage or maintenance hangar that has high visibility and the potential for generating revenue. The section on automobile parking discusses parking for a hangar. When planning a hangar apron, consider the size the facilities and the anticipated parking requirements and appropriate flexibility provided for such.

Plan Evaluation

Exhibit 5-21 provides a simple checklist to help evaluate the proposed development plan for conventional hangars.

Exhibit 5-20. (Continued).



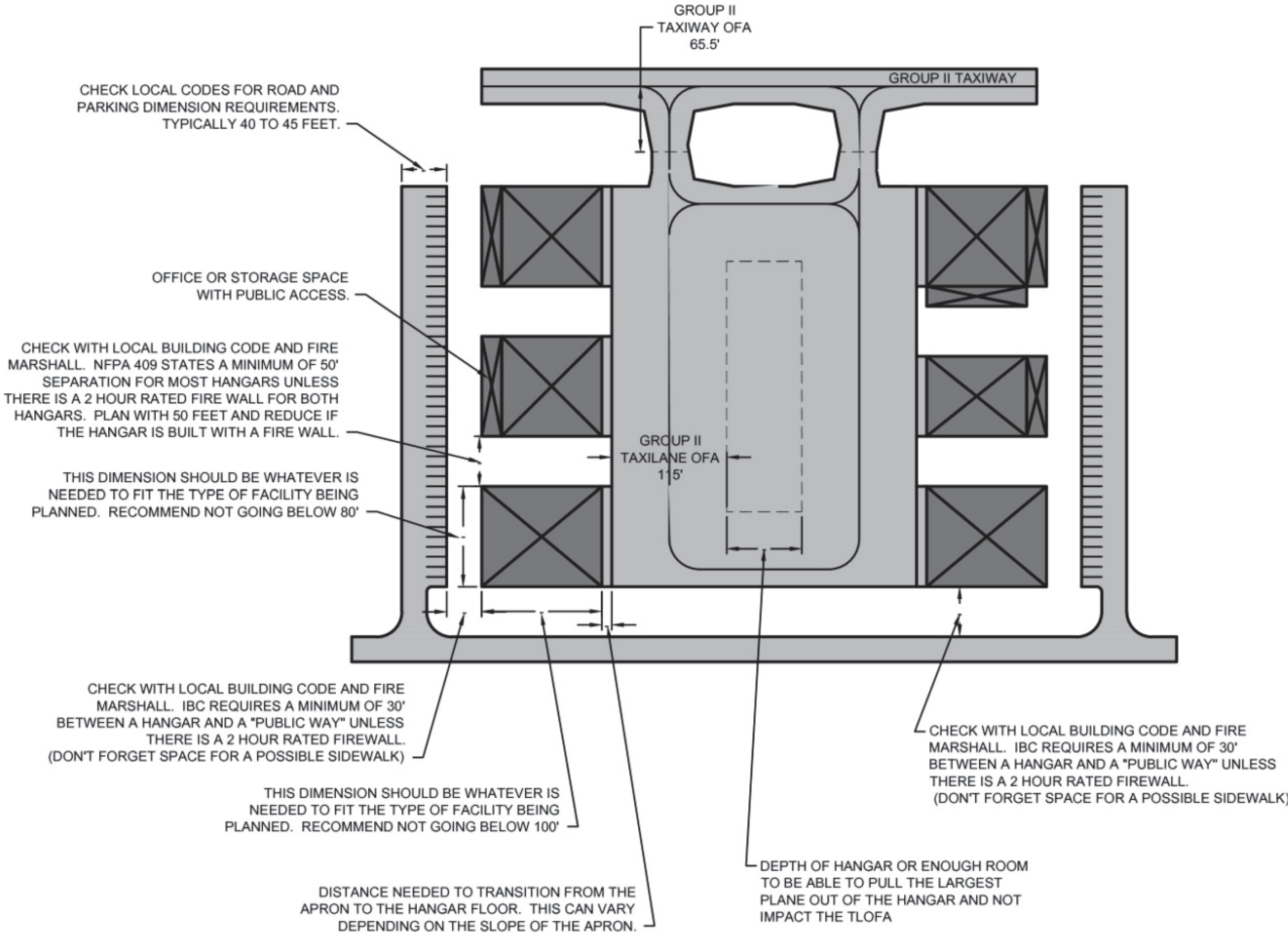
Hangar Apron Pod with Aircraft Parking.

(continued on next page)

Exhibit 5-21. Conventional hangar development plan checklist.

Criteria	Yes	No	Comment
Meets the Airport's needs			
Maximizes development space			
Does not interfere with other nearby or future development			
Does not impact or restrict taxilanes or taxiways			
Meets local building code			
Meets FAA design criteria			
Provides space to meet local engineering requirements (i.e., stormwater and erosion control)			
Interacts well with other facilities			
Provides room for expansion			
Within the project budget			

Exhibit 5-20. (Continued).



Hangar Apron Pod with Central Aircraft Parking

T-Hangars

Effective t-hangar planning also includes access planning and automobile parking planning. There will be considerable cross-over with these other facilities because they are all interconnected. Pick the right location and size so they interact well with other GA facilities and maximize development space.

Questions to ask when planning t-hangars:

- Is there an airport master plan and what does it say about t-hangars?
- Will there be an architectural theme and how will that affect layout, size, and location?
- Are there significant engineering issues (e.g., cut/fill challenges)? Drainage challenges?
- Are there existing and planned utilities to meet building needs?
- Will construction affect other facilities on the airport and does that need to factor into planning?
- What type t-hangars are needed?
- What size t-hangars are needed?
- Are different size t-hangars needed?

- How much developable space is available?
- Is there room for infill or is greenfield development required?
- Is roadway access to the t-hangars and parking required?
- Do the t-hangars have to interact with other facilities or can they be remote?
- Will the building need to be expanded in the future?
- Will the t-hangar be built as a larger group or a single standalone facility?

Location & Orientation

A t-hangar location should

- Not obstruct the view to or from the terminal building or an FBO building to the runway.
- Ensure that hangar tenants do not have to cross active taxiways or runways to reach the facility.
- Not interfere with the possible expansion or construction of other airfield facilities.
- Meet AC 150/5300-13A and FAR Part 77 guidelines.
- Maximize the space available and not restrict additional development around it.
- Be near needed utilities.
- Be with similar sized hangars.
- Ensure that vehicle access and parking space is available.
- Not be on a primary taxiway.

A t-hangar should be oriented so that in regions that have ice and snow, the doors do not face north, blocking the apron in front of the door from the sun and so that the primary wind direction is not into the hangar.

These location and orientation situations cannot always be avoided due to the orientation of the runway, existing airfield infrastructure, and the need to maximize development space.

Type & Size

There are two common types of t-hangars: standard and nested. The standard t-hangar configuration produces a longer and narrower building than a nested t-hangar. Standard t-hangars work where the existing infrastructure or available development property is not wide enough for a nested t-hangar. Layouts for nested and standard t-hangars are depicted in Exhibit 5-22.

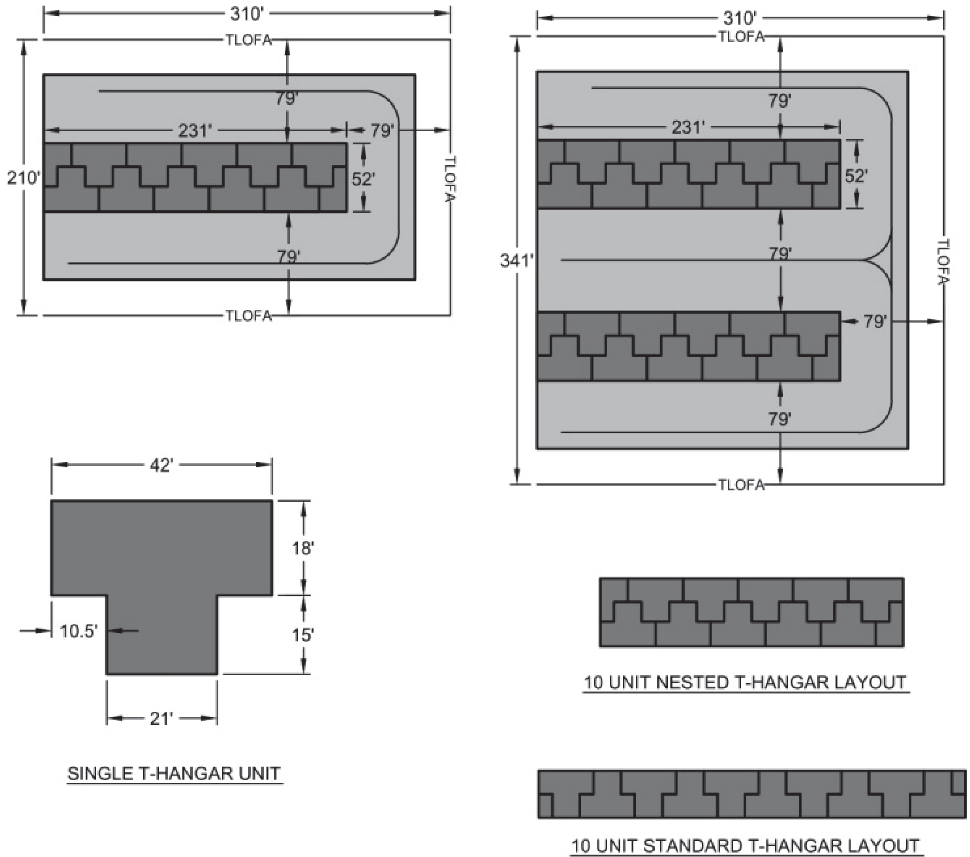
The nested t-hangar configuration produces a shorter and wider building than the standard t-hangar. This type will optimize the developable space and reduce the required taxilane pavements. This type also allows for the construction of a larger rectangular unit or jet pod on the ends of the building for larger aircraft. Nested t-hangars are the most common t-hangars. T-hangars come in all sizes. They can be custom sized or a typical size can be chosen from one of the several hangar manufacturers.

For planning, the following dimensions can be used for the most common sized t-hangars. If larger aircraft are expected, a wider or deeper hangar can be used. Exhibit 5-23 presents typical hangar dimensions from several t-hangar manufacturers for Group I aircraft.

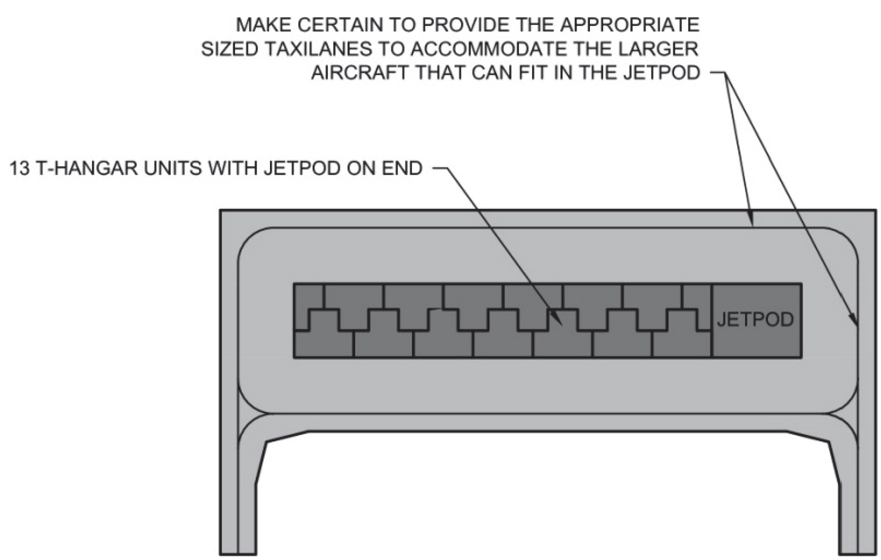
Building Codes and Hangar Spacing

T-hangars follow the same building code requirements as conventional hangars with regard to fire protection and building separation and setback. Depending on the size of the t-hangar and the local requirements, t-hangars between 12,000 square feet and 24,000 square feet may need a firewall so that no space within the building shell exceeds 12,000 square feet. T-hangars over

Exhibit 5-22. Planning t-hangar building dimensions.



Group T-Hangar Spacing and Dimensions



Nested T-Hangar with Jetpod

Source: Delta Airport Consultants, Inc.

Exhibit 5-23. Planning t-hangar building dimensions.

No. of Units	Nested T-hangar	Standard T-hangar
6	147' long by 52' wide	200' long by 36' wide
8	189' long by 52' wide	263' long by 36' wide
10	231' long by 52' wide	326' long by 36' wide
12	273' long by 52' wide	389' long by 36' wide
14	315' long by 52' wide	452' long by 36' wide
16	357' long by 52' wide	515' long by 36' wide
18	399' long by 52' wide	Not common
20	441' long by 52' wide	Not common

Sources: Delta Airport Consultants, Inc., Erect-a-Tube, Inc., Fulfab

24,000 square feet may require special fire protection measures. Consult NFPA 409 and the local fire marshal for additional guidance.

Most t-hangars accommodate Group I aircraft. To maximize space, multiple t-hangars should be spaced the width of a Group I taxilane OFA which is 79 feet. Exhibit 5-24 provides dimensions for nested t-hangar groups. Using the dimensions in Exhibit 5-24 for a single row of 10-unit nested t-hangars with a single exit, the area needed for the t-hangar, including the TLOFA, will be a minimum depth of 210 feet and a length of 310 feet. Exhibit 5-25 includes a typical layout.

One of the best ways to maximize development space is to plan facilities to be parallel and perpendicular to each other as much as possible. Angles create unusable space. Making t-hangars parallel and perpendicular to other facilities and airfield infrastructure also provides for safer traffic flow and expandability.

Another way to maximize space is to share taxiways and taxilanes as much as possible. This will reduce the "wasted" space reserved for OFAs.

Exhibit 5-24. T-Hangar Area Dimensions

Nested T-Hangar Depths (Group I)

No. of Rows	Depth (ft)
1	210
2	341
3	472
4	603
5	734
6	865

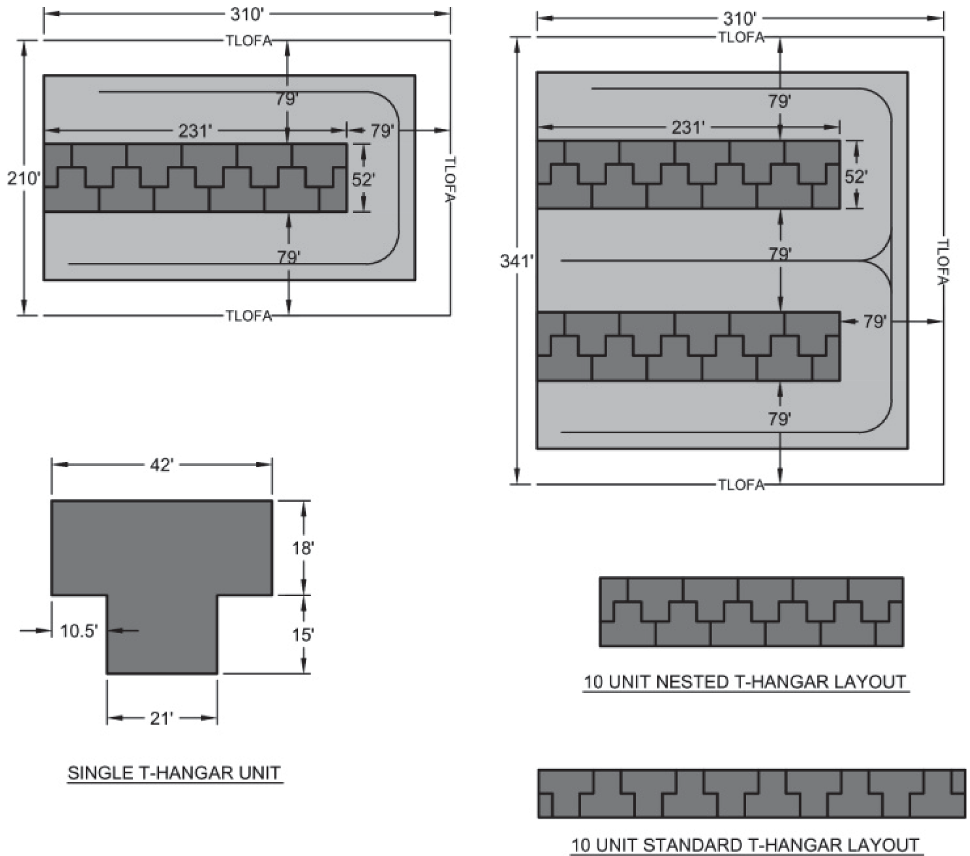
Note: For each additional row add 131 feet

Nested T-Hangar Lengths (Group I)

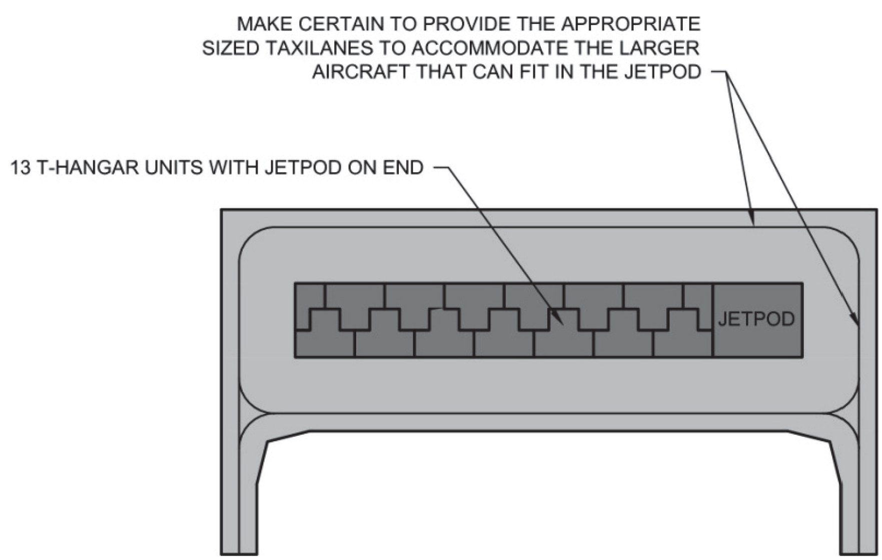
No. of Units	Length (ft)	
	Single Exit	Dual Exit
6	226	305
8	268	347
10	310	389
12	352	431
14	394[2]	473
16	436[2]	515
18	478[2]	557
20	520[2]	599

Notes: 1. For each additional unit and odd numbered units add 21 feet
2. Not recommended. See Exhibit 5-26
3. See Exhibit 5-26 for single and dual exit examples

Exhibit 5-25. T-hangar spacing and dimensions.



Group T-Hangar Spacing and Dimensions



Nested T-Hangar with Jetpod

Source: Delta Airport Consultants, Inc.

Security

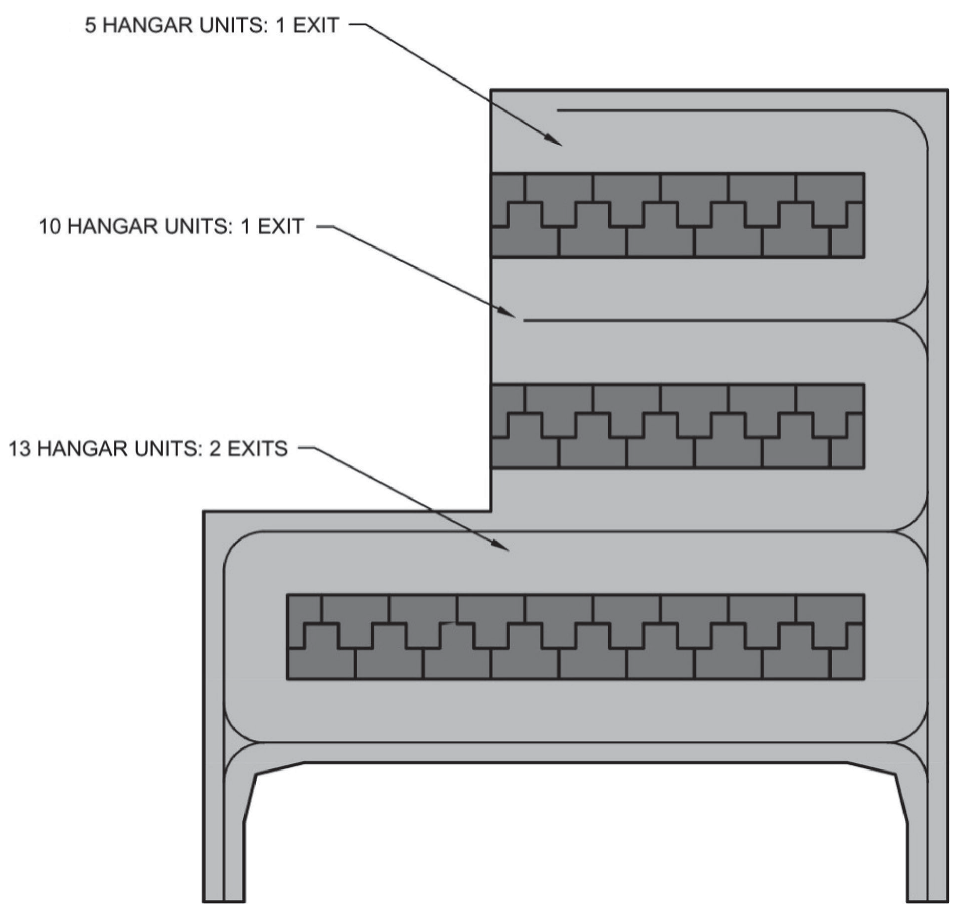
Recommendations for basic security measures for a t-hangar include tamperproof locks on all doors and enough lighting on all sides of the hangar to sufficiently illuminate the area. Additional and more expensive measures would include a monitored alarm system with cameras. Shade ports cannot offer any additional security beyond the locked aircraft and area lighting around the building. If the building is part of the security perimeter, appropriate airside access security measures will need to be incorporated into the building. The TSA has guidelines on security for GA airports. These guidelines can be found in "Security Guidelines for General Aviation Airports," Information Publication A-001, May 2004. It is recommended that these guidelines be consulted when planning this type of facility.

Other Considerations

T-Hangar Clusters and Access

When numerous t-hangars are clustered together to maximize development space, maneuvering many small aircraft may require multiple avenues of taxi. A good planning rule of thumb is that if there are more than 12 hangar units on a single taxilane, a second exit or taxi route should be provided. The more hangar units there are on a taxilane with one exit increases the chance of conflicts between departing and arriving aircraft. All instances cannot be avoided and sometimes the space constraints and budget will not allow multiple exits, but multiple exits will help to mitigate conflicts. Exhibit 5-26 depicts this situation.

Exhibit 5-26. T-hangar exits.



Source: Delta Airport Consultants, Inc.

In addition to multiple exits from the taxilanes where a large number of t-hangars are concentrated, dual taxilanes or bypass hold aprons may be required for aircraft to maneuver to and from the taxilanes. Use AC-150/5300-13A for parallel taxilane separation. Exhibit 5-27 depicts both options.

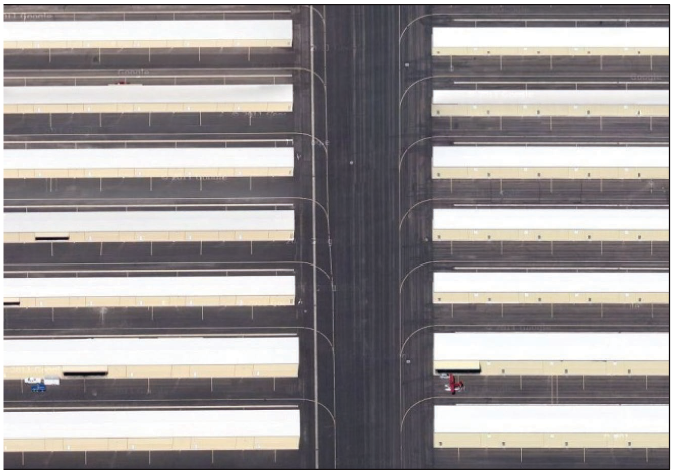
Utilities

For large clusters of t-hangars that are remotely located or do not have convenient access to a restroom, it may be beneficial to plan for a restroom in one of the end storage units. This will require access to water and sewer connections and may dictate the locations of the hangars and may affect the budget.

Shade Ports

An inexpensive alternative to a t-hangar is a shade port. A shade port provides overhead shelter from rain, snow, and sun. Shade port locations and dimensions can follow the guidelines for both standard and nested t-hangars. Shade ports do provide flexibility due to the less expensive construction cost compared to a t-hangar, and they are less expensive to move if needed for other development. They do not provide the security of enclosed hangars.

Exhibit 5-27. T-hangar dual taxilane and bypass apron.



Dual Taxilane

Bypass Apron

Source: Google Earth, Digital Globe

Engineering & Construction

Engineering issues that should be considered include

- Stormwater and erosion control measures may require the size of the apron to be adjusted to fit the space available.
- Be aware of the grades in the area. Do not plan or construct up to the property or lease line. Provide adequate buffer for grade tie-ins, grading limits, drainage swales, and storm sewer facilities.
- Security fence and gate locations.
- Grading limitations due to the flat finished floor of the long and narrow buildings.
- Taxilane grades that need to be flat enough for aircraft to be pulled into and out of the hangars but sloping enough to drain.
- How construction and phasing may impact existing facilities.

Facility-to Facility Relationships

T-hangar interaction with other GA facilities can be significant or none at all. The primary purpose of a t-hangar unit is to shelter a single aircraft. If the airport fuel is delivered only from a fuel tender, the aircraft may not need to leave the t-hangar area except to get to and from the runway. T-hangars can be remote to other facilities, because they generally do not need other facilities on a regular basis. The most common other facility discussed in this Guidebook that the t-hangar interacts with would be access and parking.

Plan Evaluation

Exhibit 5-28 is a simple checklist to help evaluate the proposed development plan for t-hangars.

Exhibit 5-28. T-hangar development plan checklist.

Criteria	Yes	No	Comment
Meets the Airport's needs			
Maximizes development space			
Does not interfere with other nearby or future development			
Does not impact or restrict taxilanes or taxiways			
Safe and efficient traffic flow			
Meets FAA design criteria			
Provides space to meet local engineering requirements (i.e., stormwater and erosion control)			
Works well with other facilities			
Provides room for expansion			
Within the project budget			

Fuel Farm Facility

A fuel farm facility can be one of the most costly facilities on an airport that has limited or no funding from state or federal sources. Careful planning is needed to provide a fuel facility that meets the existing and long-term needs of the airport or fuel farm facility owner.

Questions to ask when planning an aviation fuel farm facility:

- Is there an airport master plan and what does it say about a fuel farm facility?
- Are there significant engineering issues (e.g., cut/fill challenges)? Drainage challenges?
- Are there existing and planned utilities to meet facility needs?
- Will construction affect other facilities on the airport and how does that affect planning?
- Will the facility need to expand?

- What types of fuel are needed?
- What are the local environmental requirements?
- Is the fuel to be dispensed by fuel tender or will it be a self-service facility?
- Will the facility be used by multiple FBOs or operators?
- Will the facility be remote or close to the terminal and main apron?
- Is the facility inside the perimeter fence, outside the perimeter fence, or on the perimeter?
- Will there be secondary containment for the tanks?
- Will there be secondary containment for the fueling transfer vehicles?
- Will there be dedicated parking with secondary containment for fuel tenders?

Location & Type

The fuel farm facility should be located

- To provide safe and easy ingress and egress for the fuel delivery truck. The delivery trucks should not have to cross active airfield pavements to reach the facility.
- To provide safe and easy ingress and egress for the fuel tenders.
- To provide safe and easy ingress and egress for aircraft to and from a self-service area.
- Outside taxiway and TLOFAs.
- So that self-fueling aircraft are parked outside OFAs.
- So that it does not interfere with other aircraft or airfield operations (e.g., ARFF).
- So that it is not next to a parallel or primary taxiway.
- Near necessary utilities.
- So that it does not interfere with the possible expansion or construction of other airfield facilities.
- To avoid prop wash and jet blast.

The two primary components to planning the location of a fuel farm are (1) access to the site for the fuel delivery truck and access to the site from either fuel tenders or aircraft and (2) proximity to other facilities.

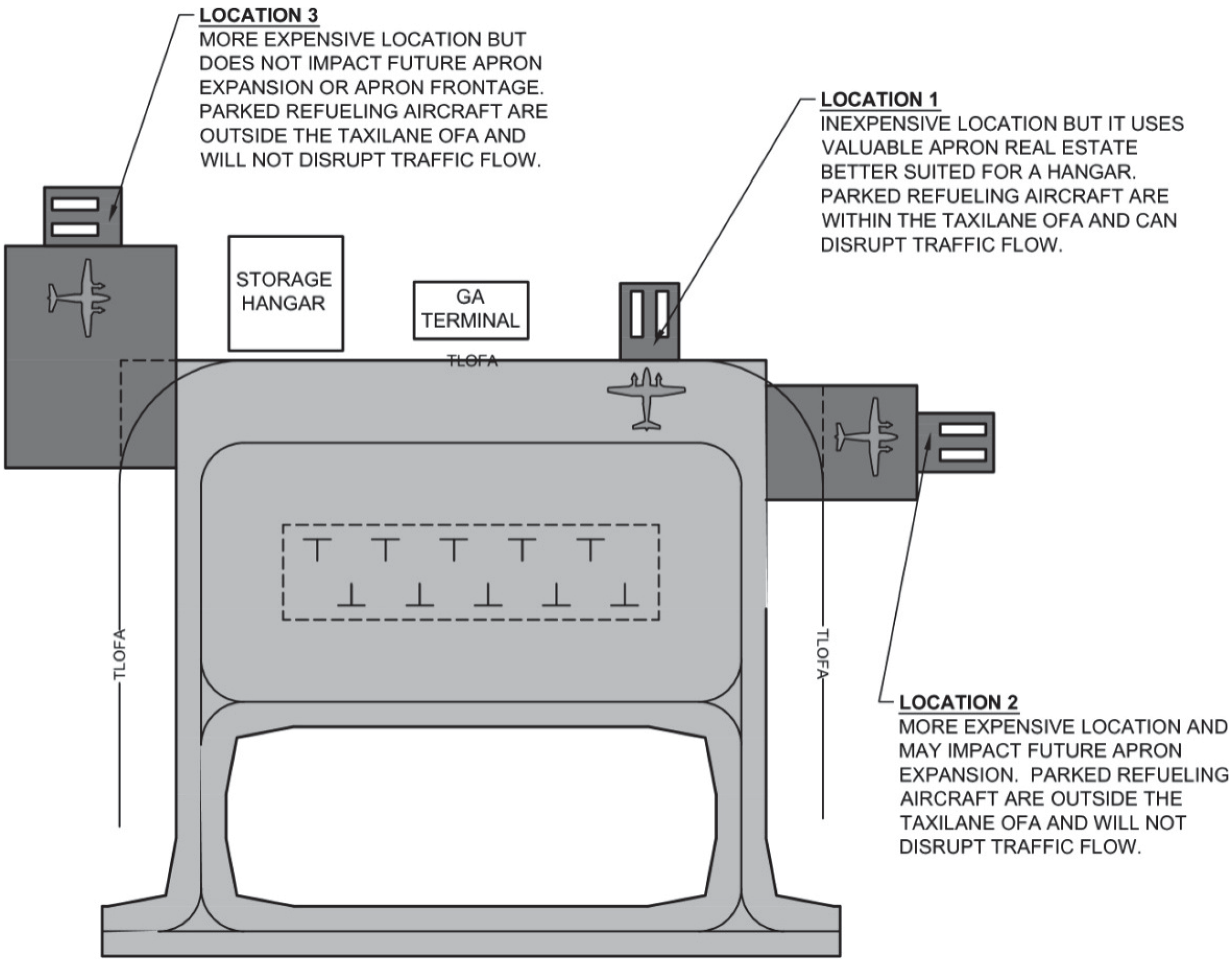
When considering the location and access to the site for the delivery truck, the unfamiliarity of the driver with the airport and maneuverability are critical. The facility should not require the delivery vehicle to interact with aircraft activity. The delivery vehicle should not have to cross any aprons, taxiways, t-hangar taxilanes, or runways to reach the facility. The ideal location would be such that the delivery vehicle does not have to enter the secure fenced portion of the airport. This would eliminate any chance of a confused driver wandering onto the wrong piece of airfield pavement.

Delivery trucks are long and heavy—this does not work well with lighter airfield pavements and tight spaces. Maneuvering by delivery trucks on light airfield pavements not designed for heavy fuel trucks will greatly reduce the life of the pavement and increases the chance of foreign object debris (FOD). The ideal flow for a delivery truck would be to drive straight through the loading area instead of having to back in or back out. Exhibit 5-29 depicts several different locations for small self-service fuel farm facilities near the main apron and the advantages and disadvantages of each.

The type of fuel farm facility will depend on the existing and long-term needs of the fuel farm operator and the budget.

Semi-Permanent. A semi-permanent fuel farm will consist of one or two fuel tanks with minimal infrastructure—this provides the option of relocating the fuel farm facility in the future with minimal expense. The tanks are usually double-walled with all the mechanical equipment integrated with the tank. The infrastructure usually consists of a concrete foundation for the tank. These are usually self-service facilities, but can also be used by

Exhibit 5-29. Small self-service fuel farm locations.



Note: Dark areas indicate secondary containment areas
Source: Delta Airport Consultants, Inc.

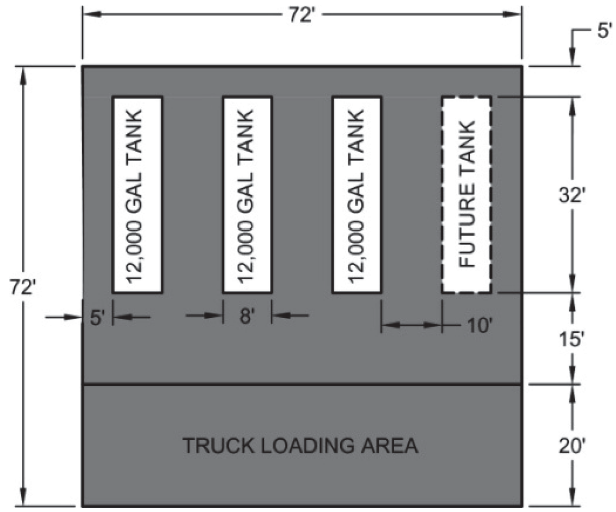
fuel tenders. Utilities for this type of facility usually include power and communication. Exhibit 5-29 depicts this type of facility with three possible locations relative to the terminal area.

Permanent. A permanent fuel farm facility includes significant infrastructure and provides room for the long-term needs of the airport or operator. A large secondary concrete containment facility with room for expansion is usually constructed. The tanks, piping, and mechanical equipment are assembled on site which allows for multiple sized tanks and expansion capabilities. A containment area for fuel truck transfers is also usually included. These facilities can also be remote from the terminal area so as not to interfere with future development. These are usually constructed when fuel tenders are used to fuel aircraft, but can also have a self-service capability. Utilities for this type of facility usually include power, communication, and possibly sanitary sewer. Exhibits 5-30 and 5-31 depict this type of facility.

Size & Layout

The size of an aviation fuel farm will depend on the amount and types of fuel needed which are determined by the projected fuel usage based on historical figures or determined from the

Exhibit 5-30. Typical fuel farm dimensions.



Note: Dark areas indicate secondary containment areas
Source: Delta Airport Consultants, Inc.

master plan. Once the type and amount of fuel needed is determined, the local or regional fuel suppliers should be contacted to determine fuel delivery schedules. The size of the tank chosen for each type of fuel may depend on how often the type of fuel can be delivered and the cost of each delivery. If the delivery schedule is not frequent enough, a larger tank may be necessary to maintain an adequate supply.

The standard fuel delivery truck is approximately 8,000 gallons. Almost all newer aviation fuel tank systems include a floating suction system to offload fuel. A floating suction system reduces the capacity of the fuel tank. For example, a 12,000 gallon tank with a floating suction system results in approximately 1,800 gallons worth of unusable space. A 12,000 gallon tank with floating suction does not need to be empty to receive a full delivery of 8,000 gallons. A 10,000 gallon tank would have a hard time taking a full truck unless the tank were empty. If space is an issue or low fuel sales are anticipated, a smaller 8,000 or 10,000 gallon tank should suffice. If a smaller tank is chosen, a containment area big enough to accommodate a future larger tank should be considered.

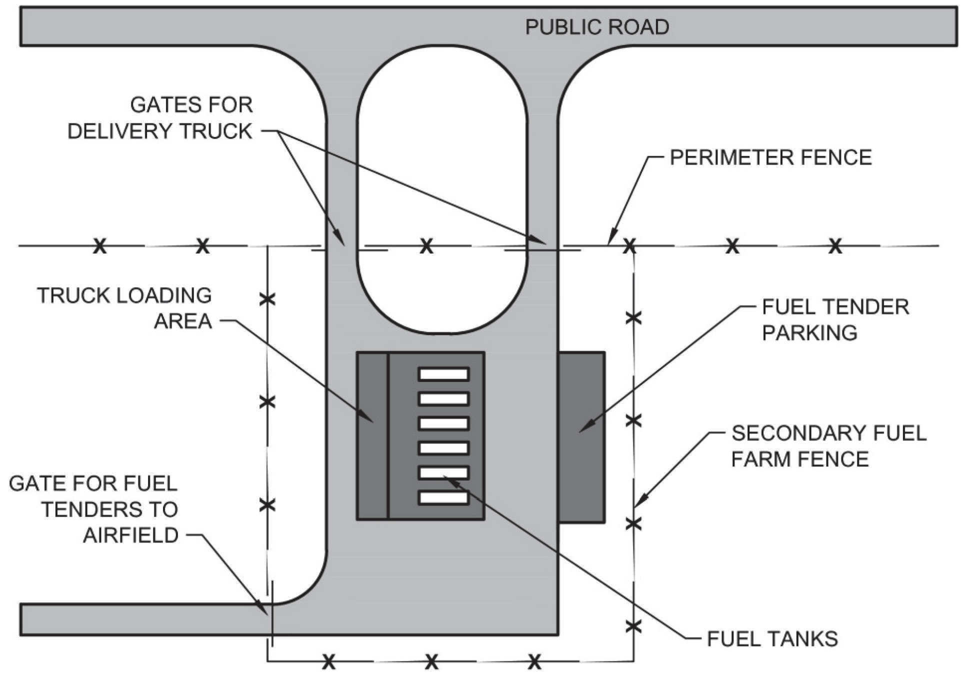
Example

If a fuel farm needed three 12,000 gallon tanks and a secondary containment for the tanks and the delivery truck transfer area, the following planning guidelines would be used.

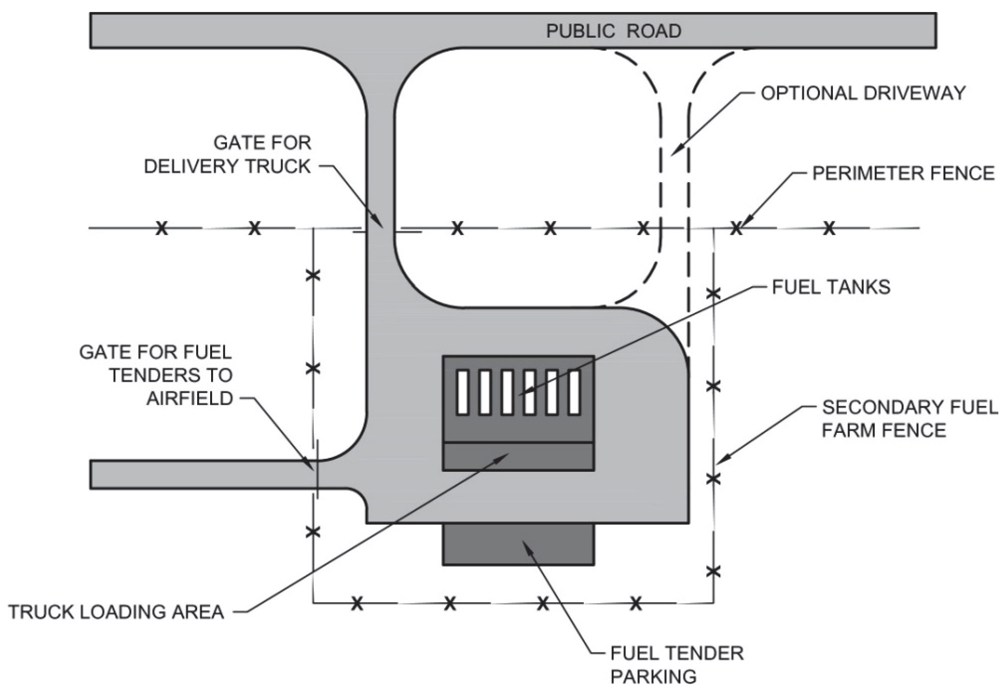
- Tank dimensions: 32 feet long by 8 feet wide
- Space between the tanks: 10 feet
- Secondary containment on sides and back of tanks: 5 feet
- Area in front of tanks for mechanical equipment skid: 15 feet
- Delivery truck transfer area: 70 feet long and 20 feet wide

Total fuel farm size for four tanks (future expansion), not including maneuver area for delivery trucks, would be approximately 72 feet wide and 72 feet deep.

Exhibit 5-31. Large fuel farm layouts.

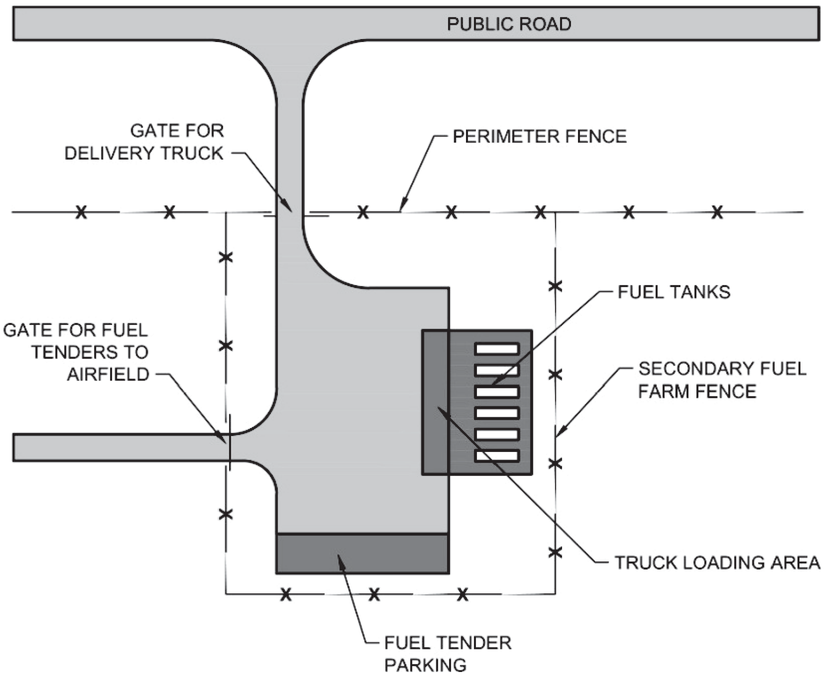


Sample 1

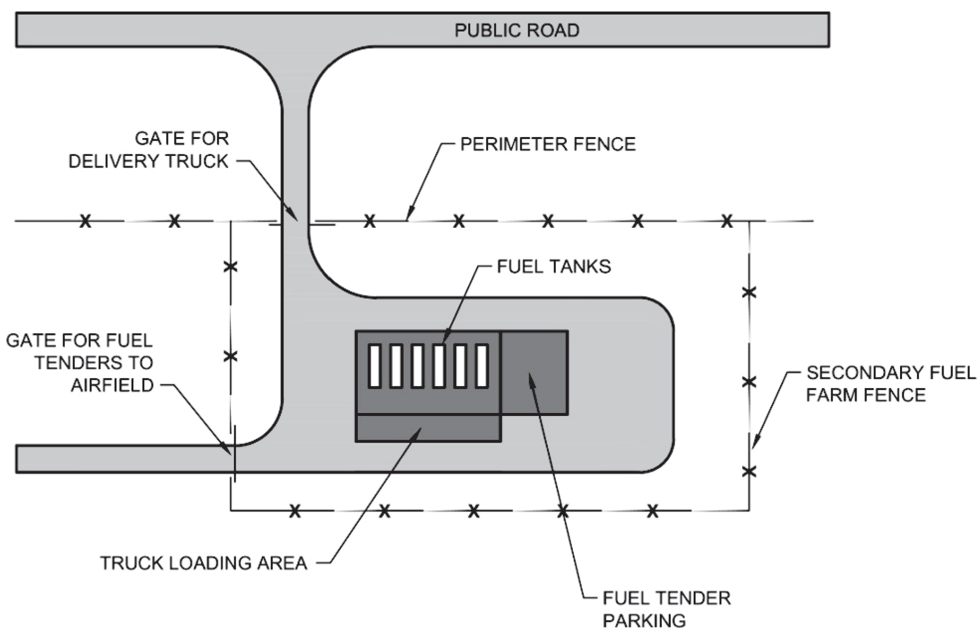


Sample 2

Exhibit 5-31. (Continued).



Sample 3



Sample 4

Note: Dark areas indicate secondary containment areas
Source: Delta Airport Consultants, Inc.

Fuel tanks can be either horizontal or vertical. Horizontal tanks are more common for tank sizes less than 30,000 gallons.

The layouts differ between the semi-permanent and the permanent types of fuel farms. The semi-permanent farm layouts have very little infrastructure. The greatest impact of a semi-permanent fuel farm is the required clear area around the fuel system in accordance with NFPA 407 "Standard for Aircraft Fuel Servicing." At a minimum, no fuel system should be within 50 feet of any building.

At least one fuel tank should be provided for each fuel type. The number for each tank per fuel type will depend on the anticipated operations and fuel use as determined by the master plan. Exhibit 5-31 depicts sample layouts of large remote fuel farms. One of the best ways to maximize development space is to plan facilities to be parallel and perpendicular to each other as much as possible.

Security

Recommendations for basic security measures for a fuel farm include an 8-ft chain link fence with barbed wire and enough lighting to sufficiently illuminate the entire farm. Additional and more expensive measures would include security cameras and after-hours alarms. The TSA has guidelines on security for GA airports. These guidelines can be found in "Security Guidelines for General Aviation Airports," Information Publication A-001, May 2004. It is recommended that these guidelines be consulted when planning this type of facility.

Other Considerations

Fuel Tender Parking

A dedicated area for fuel tenders is required in many localities to meet current regulations. A fuel tender is considered a mobile fuel farm and must meet many of the same guidelines as a fuel farm. When not in use, fuel tenders are to be parked in a location that has secondary containment similar to a fuel farm. A dedicated parking area for fuel tenders would involve a concrete area surrounded by curbing to contain a fuel spill for collection and disposal. Fuel tender parking also requires a minimum separation distance of 10 feet between parking spaces. The size of the parking area will depend on the number of vehicles and the length of the longest vehicle. For planning purposes, a 10-ft parking space with 10 feet in between and on the edges will determine the width. A depth of 30 feet should accommodate the typical fuel tender and allow for containment in the rear.

Fuel tender parking can be in many places. A spot adjacent to the fuel farm can provide economies of scale by using the same facilities for containment and disposal. Sometimes the fuel farm is too far from the aircraft that need refueling and a parking area is needed closer to the main apron. When locating fuel tender parking near the terminal area, care must be taken to provide the required separation distances from aircraft and buildings (50 feet) and remain outside OFAs. See NFPA 407 for additional information.

Engineering & Construction

Engineering issues that should be considered include

- Stormwater and erosion control measures that may require the size of the impervious areas to be adjusted to fit the space available.
- The grades in the area. Do not plan or construct up to the property or lease line. Provide adequate buffer for grade tie-ins, grading limits, drainage swales, and storm sewer facilities.
- The potential for jet blast.

- Access to utilities including, power, communication, and sanitary sewer.
- Driveway grades need to be flat enough for delivery trucks and fuel tenders to maneuver around and park next to the facility during fuel transfer operations.
- Security fence and gate locations.
- Construction and phasing impacts on existing facilities.
- Preparation or update of the Spill Prevention and Countermeasures Control Plan (SPCC) for the facility.

The Ideal Fuel Farm

The ideal fuel farm would include the following characteristics:

- Above ground fuel tanks
- At least one 12,000 gallon tank per fuel type
- Room for expansion for at least one additional 12,000 tank
- A concrete containment area for existing and future tanks
- Room for smaller non-aviation fuel tanks like diesel or unleaded fuel
- A concrete containment area for fuel delivery and tender trucks during fuel transfers
- Located inside the security fence so fuel tenders do not have to use public roads
- Landside access for delivery truck that does not enter AOA and does not require the vehicle to back up at any time
- Ample area lighting
- Security fence
- Containment area for fuel tender parking
- Located so future development is not restricted
- Option for self-service capability that does not affect other airfield operations

Facility-to-Facility Relationships

How a fuel farm interacts with other GA facilities depends on the facility. A small semi-permanent fuel facility will likely be close to a main apron, hangar, or terminal building where most activity is located. Locating a fuel farm near these GA facilities will likely affect them in the future should development needs arise. A larger remote facility may have little to no interaction with other GA facilities other than vehicle access.

The fuel farm could also be near the maintenance equipment storage building or wash rack to share common utilities. Locating the fuel farm with the maintenance equipment storage building, airfield electrical vault, and emergency generator could also reduce response time to problems and access to tools and equipment in case of an emergency.

Fuel farm facilities are neither the nicest looking facilities nor the most aromatic. Potential corporate hangars, GA terminal buildings, and FBO buildings may not be appropriate near or within sight of a fuel farm facility.

Plan Evaluation

Exhibit 5-32 provides a simple checklist to help evaluate the proposed development plan for an aviation fuel farm.

Exhibit 5-32. Fuel farm facility development plan checklist.

Criteria	Yes	No	Comment
Meets the Airport's or operator's needs			
Maximizes development space			
Does not interfere with other nearby or future development			
Does not impact or restrict taxilanes or taxiways			
Provides space to meet local engineering requirements (i.e., stormwater and erosion control)			
Meets local environmental regulations			
Interacts well with other facilities			
Provides room for expansion			
Within the project budget			

Aircraft Wash Facility (Wash Rack)

Aircraft wash facilities (wash racks) provide GA aircraft owners with a common area with access to water to wash and clean their aircraft. A wash rack will also allow the airport to address and meet any required environmental regulations with regard to wash water. A wash rack can collect the wash water which can contain cleaning chemicals and aircraft fuel and oil. Restricting the number of areas for washing reduces the risk of discharging wash water into the environment.

Questions to ask when planning a wash rack:

- Is there an airport master plan and what does it say about a wash rack?
- Are there significant engineering issues (e.g., cut/fill challenges)? Drainage challenges?
- Are there existing and planned utilities to meet wash racks needs?
- Will construction affect other facilities on the airport and how does that affect planning?
- How many aircraft are anticipated to use the wash rack at the same time?
- What size aircraft are anticipated to use the wash rack?
- Will the wash rack need to be expanded in the future?
- What are the local environmental requirements?

Location & Type

The wash rack location should

- Provide safe and easy ingress and egress for the aircraft expected to use the facility.
- Be outside taxiway and TLOFAs.
- Not interfere with other aircraft or airfield operations (e.g., ARFF).
- Not be next to a parallel or primary taxiway.
- Be close to necessary utilities.
- Not interfere with the possible expansion or construction of other airfield facilities.
- Avoid prop wash, jet blast, and rotor wash.

Wash racks come in three basic types:

- **Open Air.** An open air wash rack is a piece of pavement completely exposed to the elements with a system that collects wash water and precipitation.
- **Covered.** A covered wash rack has a roof and open sides. This type reduces the amount of precipitation collected by the wash rack. This type requires a check of Part 77 clearances, much like a hangar.
- **Enclosed.** An enclosed wash rack is a hangar with or without a door that prevents precipitation from being collected by the wash rack facility to the maximum extent possible. This type will require a check of Part 77 clearances, much like a hangar.

The type of facility depends on the local environmental requirements, utility requirements, and funding.

Size & Layout

Wash racks are usually sized to accommodate one single aircraft at a time; however, depending on the demand and layout, multiple aircraft can be accommodated at the same time. Larger and more expensive aircraft stored in hangars are usually washed in the hangars while single-engine piston and smaller twin-engine aircraft are washed outside. To help determine the size of the wash down area, tenants should be surveyed to determine who would use the wash rack.

A good rule of thumb would be to take the aircraft with the largest wingspan and greatest length that the airport would like to accommodate and add 10 feet (5 feet each side). The 10 feet will capture overspray and provide room for personnel to walk around the aircraft.

Example 1	Example 2
Beech Baron 58	Beech King Air 200
Wingspan ~38 feet	Wingspan ~55 feet
Length ~30 feet	Length ~44 feet
Use the longer of the two dimensions, add 10, and round up to the nearest 5	Use the longer of the two dimensions, add 10, and round up to the nearest 5
Wash down area: 50 feet by 50 feet	Wash down area: 65 feet by 65 feet

If the intention is to provide an area for the largest most common aircraft in use that would use the facility, a Beech King Air B200 is a good place to start. A King Air B200 is approximately 55 feet wide by 45 feet long. In addition to the area needed for the aircraft, additional area is needed for overspray and access around the aircraft. A 65 foot by 65 foot wash area would accommodate the King Air B200 and approximately 60% of the existing aircraft fleet, including many small and mid-size business jets. If the aircraft were parked at an angle on the wash area, even larger aircraft could use the facility. Additional pavement may be required if a tug is used to pull the aircraft into position without the tug driving off the pavement. A cheaper solution would be to push the aircraft into place and then pull the aircraft out.

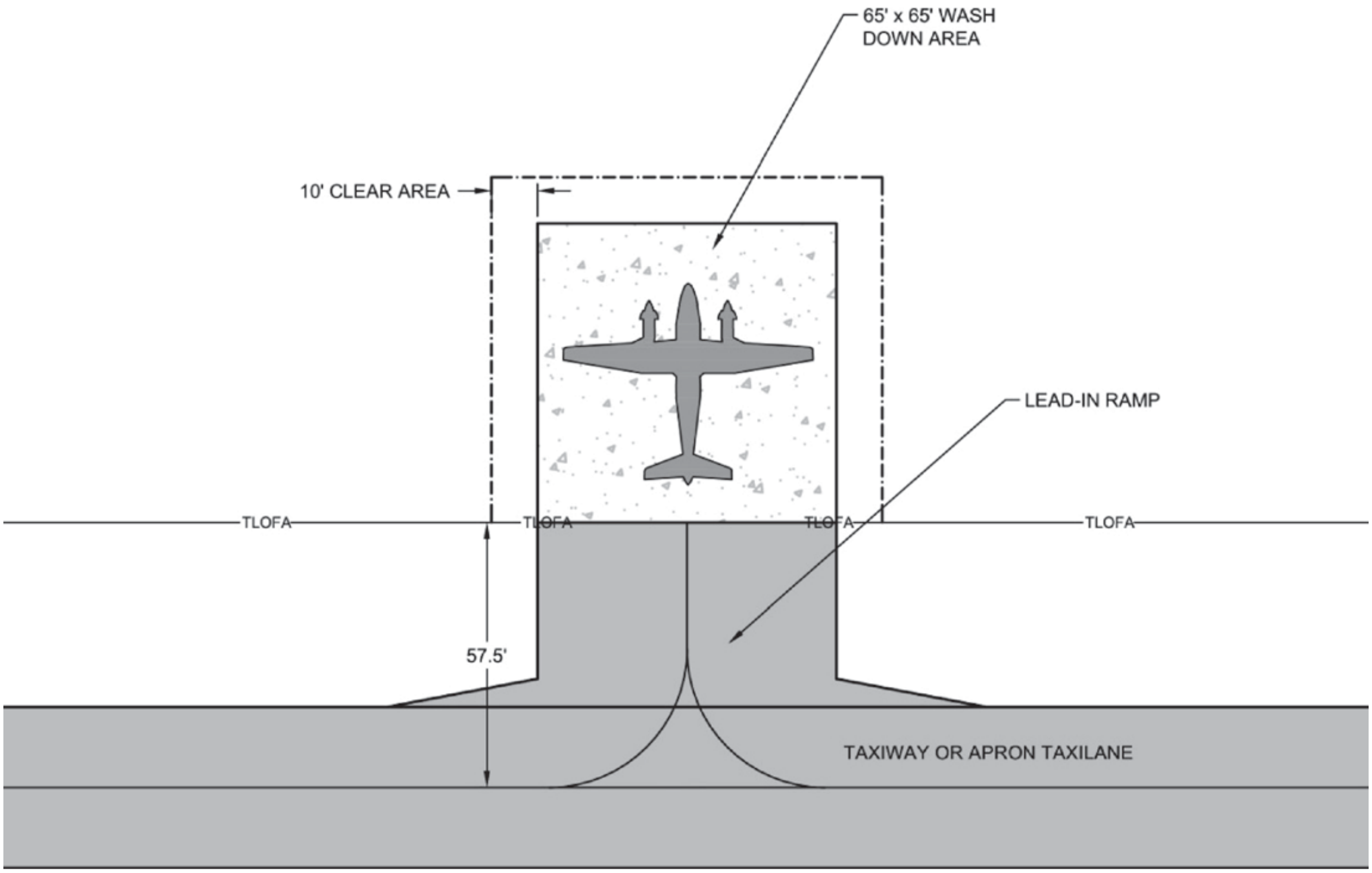
A clear area around the wash down area should be provided so aircraft can be maneuvered into and out of position. This area will also provide room to install any necessary utility apparatus (e.g., hose bibs, outlets, lights, oil/water separators, and control panels); 10 to 15 feet of clear area would be sufficient. Exhibit 5-33 provides a sample layout of a proposed wash rack.

One of the best ways to maximize development space is to plan facilities to be parallel and perpendicular to each other as much as possible. Angles create unusable space. Making a wash rack as parallel or perpendicular to other facilities and airfield infrastructure also provides for safer traffic flow and expandability.

Security

Because wash racks are within the perimeter fence, there are no special security recommendations. The TSA's "Security Guidelines for General Aviation Airports," Information Publication A-001, May 2004 should be consulted when planning this type of facility.

Exhibit 5-33. Sample wash rack layout.



Source: Delta Airport Consultants, Inc.

Water design issues:

- Hose bibs (more than one may be needed)
- Hose for the hose bibs

(the use of multiple hose bibs at the same time may result in low water pressure and should be studied)

Sanitary Sewer design issues:

- The sewer authority may require fuel traps, oil/water separators prior to discharging to their system
- The sewer authority may also require flow meters to monitor the amount of discharge

Other Considerations

Utilities

Water. In conjunction with finding a location that meets the safety and traffic flow considerations, the availability and proximity to a water source will be a significant driver in the location and cost of the facility. If a water source is readily available, a meeting with the local utility provider should be considered to determine their requirements for the facility and available water pressure.

Sanitary Sewer. If the local water and sewer authority permits the wash water to discharge into the sanitary sewer system, it will be necessary to be within a reasonable proximity to the system.

Electrical Power. Providing electrical power to the wash rack should also be considered. This would allow the use of power washers, vacuum cleaners, and other electrical cleaning equipment. Power may also be required if the wash rack system has area lighting, automated controls, and monitoring devices.

Communications. If there is a desire or plan to charge a fee for the use of the facility, a telephone line or other communications line may be required if a credit card or similar system is employed.

Wash Water Discharge

One of the first meetings when planning a wash rack should be with the local environmental agencies and the local water and sewer company. This meeting will help define what can and cannot be done with the wash water and may help determine the location and type of facility. A common requirement is that the wash water must be treated prior to discharge. There are different levels of treatment which will be determined by the local environmental agencies. Treatment can range from a fuel trap and oil/water separator to complete collection and treatment at a sanitary sewer treatment plant or similar facility. Example scenarios follow:

Possible electrical power needs:

- Outlets
- System controls
- Area lighting
- Monitoring devices
- Payment device

Scenario 1: Wash water does not need to be treated

Option A: Construct an open air facility and allow wash water to drain into a ditch or storm sewer through a fuel trap.

Option B: Construct an open air facility with the potential for future collection and treatment should regulations change.

Scenario 2: Wash water must be treated

Option A: Collect onsite for removal by truck and transport to a treatment facility

If this option is chosen, the amount of wash water to be treated should be reduced in one of the following ways:

- Construct an open air facility and install a valved system that opens during wash events and closes during precipitation events
- Construct an enclosed facility
- Construct a covered facility

Option B: Collect and discharge to the sanitary sewer system for treatment

If this option is chosen and the local utility **does not** treat precipitation, wash water should be collected in one of the following ways:

- Construct an open air facility and install a valved system that opens during wash events and closes during precipitation events
- Construct an enclosed facility
- Construct a covered facility (if acceptable to local utility)

If this option is chosen and the local utility **does** treat precipitation, the amount of wash water should be reduced in one of the following ways to reduce treatment costs:

- Construct an open air facility and install a valved system that opens during wash events and closes during precipitation events
- Construct an enclosed facility
- Construct a covered facility

All Option B scenarios may require sanitary sewer meters for additional monitoring.

If the local utility and environmental requirements are not known during the initial planning of the facility, the scenario with the greatest impact should be considered during planning.

Engineering & Construction

Engineering issues that should be considered during the planning process include

- Stormwater and erosion control measures that may require the size of the wash area to be adjusted to fit the space available.
- The grades in the area. Do not plan up to the property or lease line. Provide adequate buffer for grade tie-ins, grading limits, drainage swales, and storm sewer facilities.
- The potential for jet blast when choosing a location.
- Apron grades need to be flat enough for aircraft to be pulled into and out of the wash area but sloping enough to drain.
- Will the construction and phasing impact existing facilities.
- Prepare or update the Spill Prevention and Countermeasures Control Plan (SPCC) for the facility.

Deicing

The wash facility can also be used as a deicing facility if the facility is constructed properly. The wash facility could be constructed to contain the deice fluid until it could be collected and disposed of properly. Additional information on deicing facilities can be found in AC 150/5300-14C.

Facility-to-Facility Relationships

A wash rack can interact well with many other GA facilities and not interact well with others. A wash rack would not interact well with facilities that have pedestrian traffic or large aircraft traffic like a terminal building, FBO building, or helicopter parking area due to overspray and prop wash or jet blast. Given that wash racks are primarily used by smaller aircraft, a location in the vicinity of t-hangars or a based aircraft apron would work well together. Co-locating the wash rack with a fuel farm can be beneficial if both facilities tie to the sanitary sewer system. Both facilities may be able to use the same systems to reduce construction and maintenance costs. Locating a maintenance equipment storage (MES) building nearby can offer the same benefits if the MES building has a wash facility. Co-locating these and other facilities that require utility connections can help reduce overall construction and maintenance costs.

The Ideal Wash Rack

The ideal wash rack facility would include the following characteristics:

- An enclosed facility (no door)
- 70 feet by 70 feet with 18-ft-high opening
- Overhead lighting
- At least two hose bibs
- At least one electrical outlet per side
- A minor curb along the entrance to separate wash water from rainwater runoff
- Connection to sanitary sewer
- Overall height below Part 77 Surfaces
- Located outside taxiway and TLOFAs
- Near existing water, sewer, and electrical connections
- Reasonably accessible for aircraft owner's automobiles to transport washing supplies to the aircraft
- Clear of future development opportunities

Plan Evaluation

Exhibit 5-34 provides a simple checklist to help evaluate the proposed development plan for a wash rack.

Exhibit 5-34. Wash rack development plan checklist.

Criteria	Yes	No	Comment
Meets the Airport's needs			
Maximizes development space			
Does not interfere with other nearby or future development			
Does not impact or restrict taxilanes or taxiways			
Meets FAA design criteria			
Provides space to meet local engineering requirements (i.e., stormwater and erosion control)			
Interacts well with other facilities			
Provides room for expansion			
Within the project budget			

GA Terminal Building

Airports typically have at least one building that serves as a focal point for general aviation—for basic meeting/greeting and pilot services. Some also house airport-related businesses and airport administrative offices. GA terminal buildings range from a very basic waiting room, restrooms, and telephones to multi-story buildings with amenities such as pilot briefing rooms, pilot lounges, restaurants, gift shops, conference and training rooms, and rental car counters. The specific layout of a GA terminal is often driven by whether or not it is an airport-owned and operated facility or a private FBO building. Various types of ownership/operation models for GA terminal buildings include the following:

- Owned and operated by the airport owner who also provides aircraft and pilot services at the airport
- Owned by the airport owner but the entire building is leased to a private firm that manages the services
- Owned by the airport owner with a portion of the building for airport needs (e.g., airport administration) and a portion leased to an FBO that provides services to the GA users
- FBO owned and operated

Regardless of which ownership/operator model is used, the GA terminal facilities should meet the needs of the GA community.

Questions to ask when planning a GA terminal building:

- Is there an airport master plan and what does it say about the terminal building?
- Can associated facilities (e.g., access road, auto parking, and apron) be developed in balance with the terminal building?
- What functions will the building layout provide for?
- What kind of community outreach is needed to plan the building?
- Will there be an architectural theme and how will that affect layout, size, and location?
- Are there significant engineering issues (e.g., cut/fill challenges)? Drainage challenges?
- Are there existing and planned utilities to meet building needs?
- What community goals and standards will affect the building plans?
- Will construction affect other facilities on the airport and how does that affect planning?
- Will the building serve non-airport functions such as community activities?
- Will the building need to be expanded in the future?

Location

The GA terminal building location should

- Provide maximum visibility from the runway and/or parallel taxiway for arriving aircraft.
- Provide good visibility of the airfield from the terminal.
- Provide safe and efficient access from primary roadways.
- Be close to an adequate apron for based and transient aircraft.

- Have room for adequate automobile parking.
- Not interfere with the possible expansion or construction of other airfield facilities.
- Have room for future expansion of the building and associated parking.
- Allow easy access to utilities or areas for well water and/or a septic system.

For most GA airports, the terminal building will be the focal point of the airport. Because of this, the building should be easy to locate and navigate to from both the airside and landside. The view of the terminal should not be blocked by other buildings and other buildings should not block the view of the airfield from the terminal. The GA terminal building should be aligned with a parallel taxiway or the runway as much as possible.

Users & Services

While choosing a location for the GA terminal building, it is important to determine who the users will be and what services will be provided. These users typically include

- Pilots
  - Student
  - Corporate
  - Based
  - Transient
- Passengers
- Airport Management
- FBOs
- Restaurants
- Community

Taking the proposed users of the terminal into account, the services need to be determined. Typical services in a GA terminal building include

- Passenger Waiting Area
- Restrooms (24/7 airside access)
- Vending
- Pilot Lounge
- Pilot Room
- Mechanical Room
- Storage Room
- Circulation
- Flight Planning (including weather station)
- Conference Room
- Operations/FBO Counter
- Airport Administration
- Office Lease Space
- Restaurant

Several State Aviation System (SAS) plans have planning guidance on GA terminal buildings. The guidance ranges from the size of the building to the functions and areas inside the building. Most of the guidance is on the areas and space eligible for state funding. There are no general rules of thumb based on the different SAS plans due to the wide-ranging guidance provided.

Most SAS plans that have guidance indicate that, at a minimum, the following services should be provided:

- Passenger Lounge
- Restrooms
- Vending
- Pilot Lounge

Size & Layout

If no preliminary planning has been completed for a GA terminal building and a size needs to be determined for an ALP and for cost estimating, the following guidelines can be used. The peak-hour operations from the approved master plan will be needed to get started. For planning, a factor of 2.5 people (pilots and passengers) per peak-hour operation can be assumed. An area of 100 to 150 square feet of space per person was considered adequate to accommodate the peak-hour traffic. The square footage per person will depend on the functions anticipated and any additional areas expected in the terminal. Using these figures, the following formula can be used to provide a planning size for a GA terminal building for an ALP:

$$(\text{Peak-hour operations}) \times (2.5) \times (100 \text{ sf to } 150 \text{ sf}) = \text{Building square footage}$$

Example

Peak-Hour Operations: 10 (from Master Plan)

Square foot per person: 125 (this size was chosen due to a request by the Airport for a larger conference room and sleep rooms in the pilot's lounge)

10 x 2.5 x 125 = 3,125 sf

This formula is for general planning purposes only to help determine a size for showing on an ALP or in a master plan and initial cost estimating. Each airport will need to assess the demand for public space and private space and have an accurate forecast of operations to help determine the size and functions of the GA terminal.

Secondary space around the terminal building also needs to be planned for on an ALP. Secondary space would include walkways, entrance plazas, airside patios, landscape areas, and buffers with other buildings. Space should also be provided for future expansion of the terminal building.

Exhibit 5-35 provides sample GA terminal building layouts.

One of the best ways to maximize development space is to plan facilities to be parallel and perpendicular to each other as much as possible. Angles create unusable space. Making a terminal building as parallel or perpendicular to other facilities and airfield infrastructure also provides for safer traffic flow and expandability.

Security

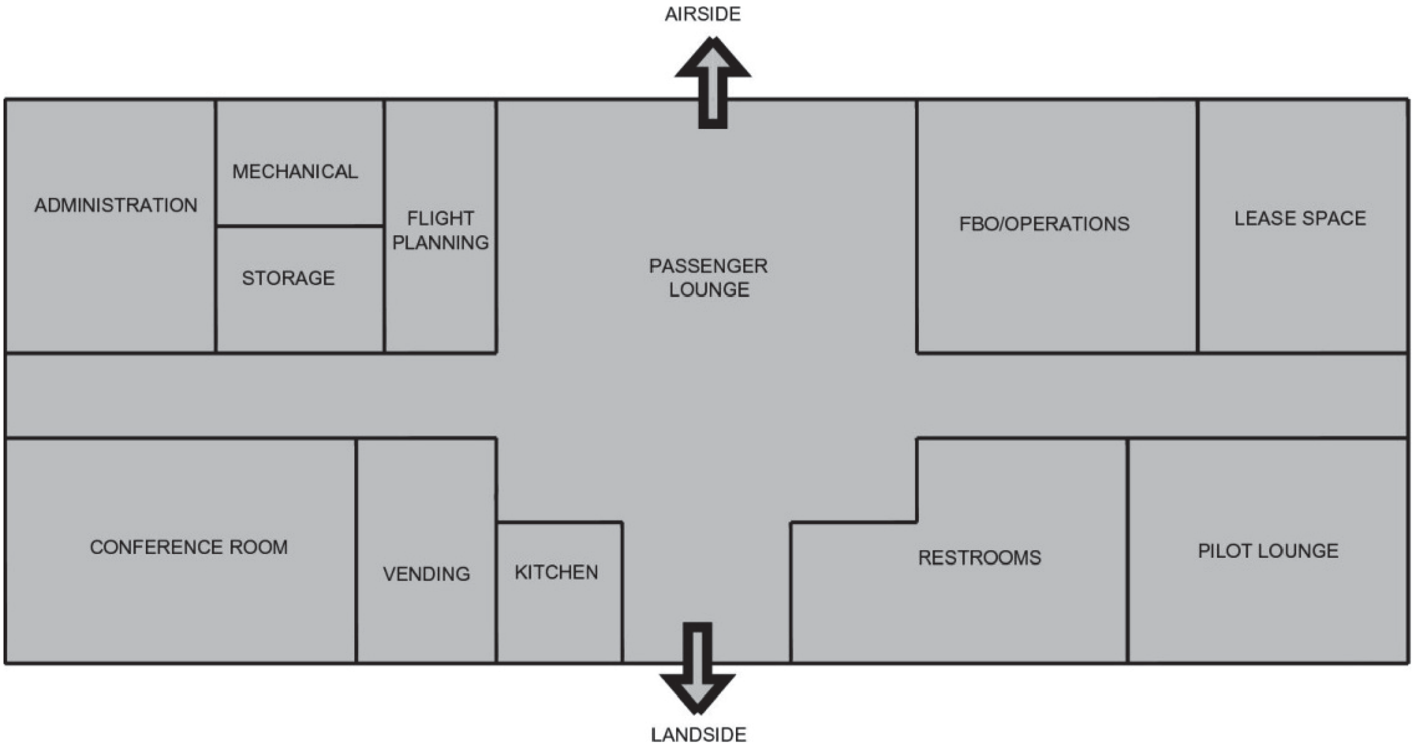
Recommendations for basic security measures for a GA terminal building include tamper-proof locks on all doors and enough lighting on all sides of the hangar to sufficiently illuminate the area. Additional more expensive measures would include a monitored alarm system with cameras. The TSA has guidelines on security for GA airports. These guidelines can be found in "Security Guidelines for General Aviation Airports," Information Publication A-001, May 2004. Ideally, these guidelines should be consulted when planning this type of facility.

Other Considerations

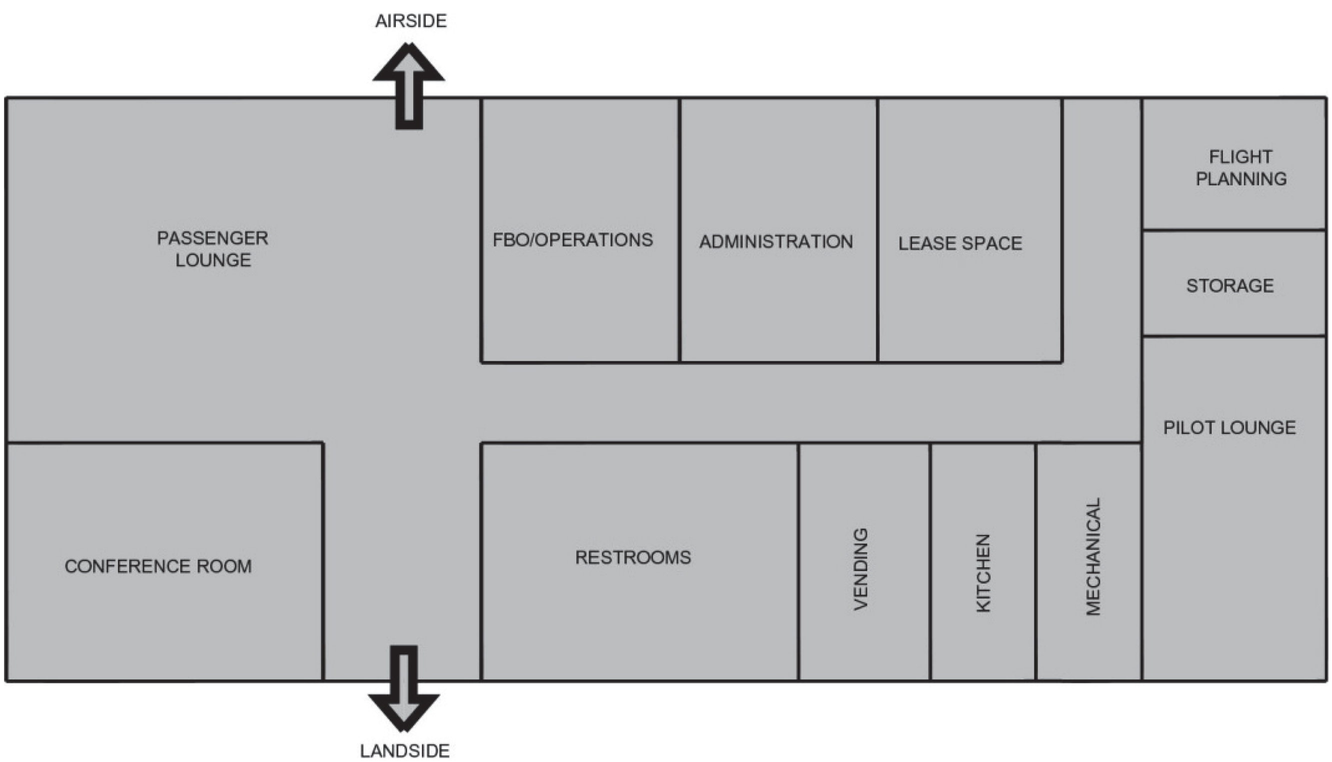
Utilities

GA terminal buildings require access to water and sewer connections. This may dictate the location of the building and may affect the budget.

Exhibit 5-35. Sample GA terminal building layouts.

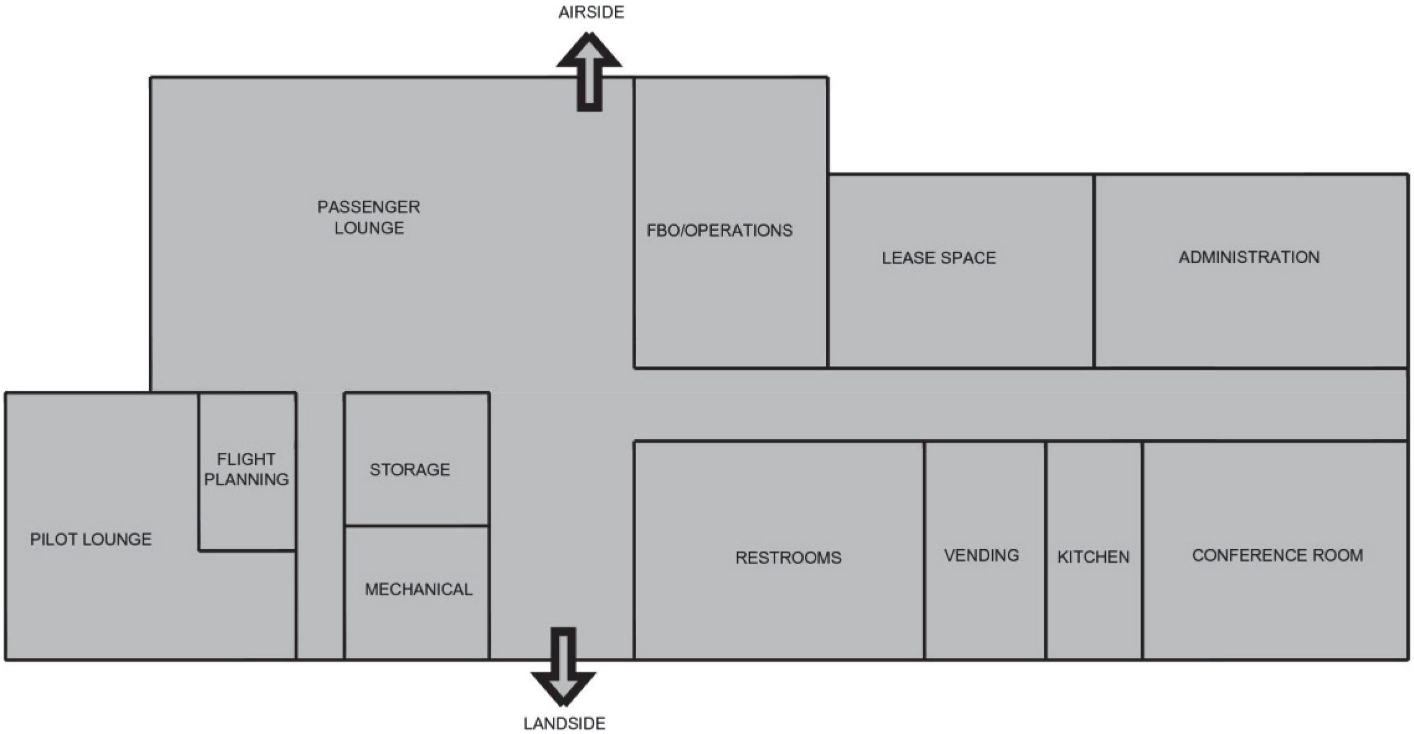


Sample 1.



Sample 2.

Exhibit 5-35. (Continued).



Sample 3.

(continued on next page)

Engineering & Construction

Engineering issues that should be considered during planning include

- Security fence and gate locations
- Grading limitations due to the flat finished floor of the building
- Stormwater and erosion control measures may require the size of the building and adjacent impervious areas to be adjusted to fit the space available
- The grades in the area. Do not plan up to the property or lease line. Provide adequate buffer for grade tie-ins, grading limits, drainage swales, and storm sewer facilities
- The potential for jet blast
- Construction and phasing effects on existing facilities

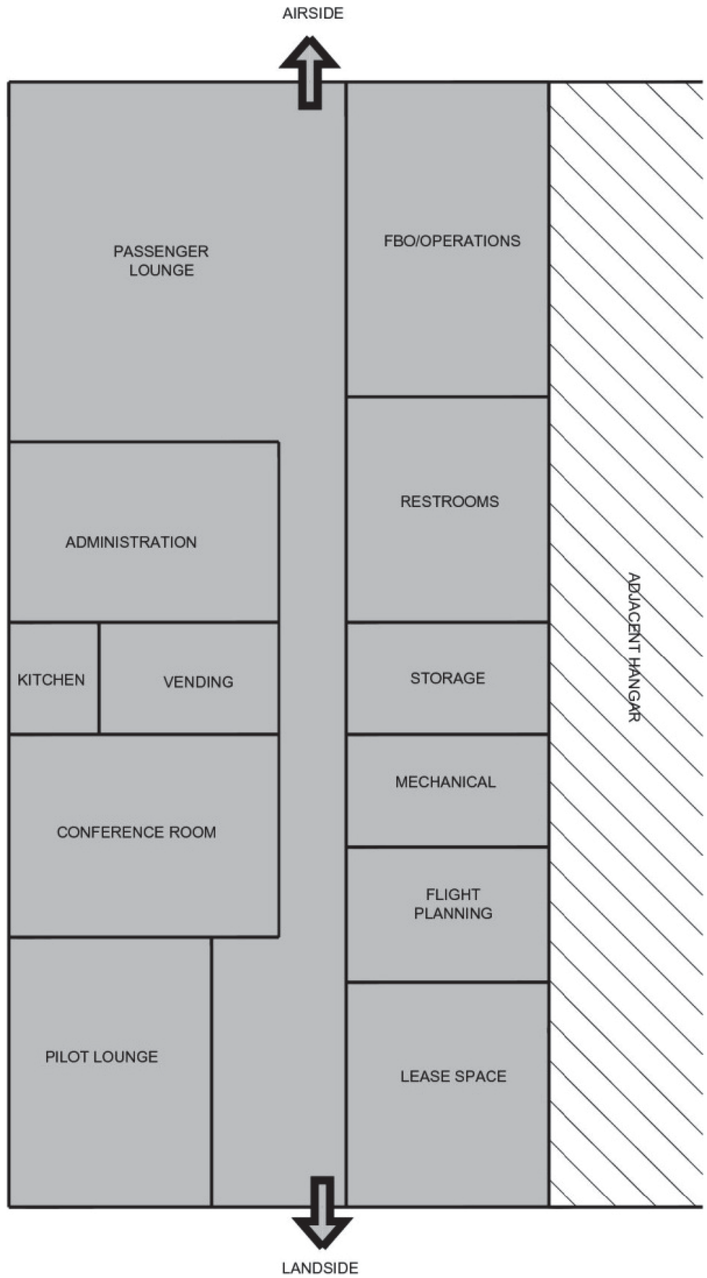
Facility-to-Facility Relationships

A GA terminal building has to interact with many other facilities, the most common being the apron and automobile parking and access. The terminal building may also interact with hangars. When a terminal building and hangars interact, the terminal building must not be hidden or blocked by the hangars. The terminal building should be closer to the runway than adjacent hangars to allow a good line of sight to the airfield. A wash rack, fuel farm, or helicopter parking apron should not be close to a terminal building. A helicopter parking apron should be far enough away to reduce rotor wash near pedestrians but close enough to allow helicopter pilots easy access to the terminal.

Plan Evaluation

Exhibit 5-36 is a simple checklist to help evaluate the proposed development plan for a GA terminal building.

Exhibit 5-35. (Continued).



Sample 4.

Note: GA Terminal Building attached to the side of a hangar
Source: Delta Airport Consultants, Inc.

Exhibit 5-36. GA terminal building development plan checklist.

Criteria	Yes	No	Comment
Meets the Airport's needs			
Maximizes development space			
Does not interfere with other nearby or future development			
Meets community needs			
Meets local building code			
Meets FAA design criteria			
Provides space to meet local engineering requirements (i.e., stormwater and erosion control)			
Interacts well with other facilities			
Provides room for expansion			
Within the project budget			

FBO Building

An FBO building is very similar to a GA terminal building. They generally serve the same function except that an FBO building is usually privately owned or publicly owned and leased to a private entity. In addition to the FBO operations, some also house airport-related businesses. FBO buildings can range from a simple building with basic waiting room, restrooms, and FBO counter to multi-story buildings with amenities (e.g., pilot briefing rooms, pilot lounges, restaurants, gift shops, conference and training rooms, and rental car counters).

Questions to ask when planning an FBO building:

- Is there an airport master plan and what does it say about an FBO building?
- Can associated facilities (e.g., access road, auto parking, and apron) be developed in balance with the FBO building?
- What functions will the building layout provide for?
- What kind of community outreach is needed to plan the building?
- Will there be an architectural theme and how will that affect layout, size, and location?
- Are there significant engineering issues (e.g., cut/fill challenges)? Drainage challenges?
- Are there existing and planned utilities to meet building needs?
- What community goals and standards will affect the building plans?
- Will construction affect other facilities on the airport and how does that affect planning?
- Will the building serve non-airport functions such as community activities?
- Will the building need to be expanded in the future?

Location

An FBO building location should

- Provide maximum visibility from the runway and/or parallel taxiway for arriving aircraft.
- Provide good visibility of the airfield from the building.
- Provide safe and efficient access from primary roadways.
- Be close to an adequate apron for based and transient aircraft.
- Have room for adequate automobile parking.
- Not interfere with the possible expansion or construction of other airfield facilities.
- Allow room for future expansion of the building and associated parking.
- Allow easy access to utilities or areas for well water and/or a septic system.

For many larger GA airports, an FBO building may be a focal point of the airport. Because of this, the building should be easy to locate and navigate to—from both the airside and landside. The view of the FBO building should not be blocked by other buildings and other buildings should not block the view of the airfield from the terminal. The FBO building should be aligned with a parallel taxiway or the runway as much as possible to maximize development space.

Users & Services

When choosing a location for an FBO building, it is important to determine who the users will be and what services will be provided. Users typically include

- Pilots
  - Student
  - Corporate
  - Based
  - Transient

- Passengers
- Restaurants

Taking the proposed users of the building into account, the services need to be determined. Typical services in a FBO building include

- Passenger Waiting Area
- Restrooms
- Vending
- Pilot Lounge
- Pilot Room
- Mechanical Room
- Storage Room
- Circulation
- Flight Planning with weather station
- Conference Room
- Operations Counter
- Office Space
- Lease Space
- Restaurant

Size & Layout

The sizing of an FBO building can use the same guidelines for a GA terminal building. The sample GA terminal building layouts provided earlier can be used for an FBO building. The main difference would be that the administrative space and lease space could be used for FBO offices. One of the best ways to maximize development space is to plan facilities to be parallel and perpendicular to each other as much as possible. Angles create unusable space. Making an FBO building as parallel or perpendicular to other facilities and airfield infrastructure also provides for safer traffic flow and expandability.

Security

Recommendations for basic security measures for an FBO building include tamperproof locks on all doors and enough lighting on all sides of the building to illuminate the area. Additional and more expensive measures would include a monitored alarm system with cameras. The TSA's "Security Guidelines for General Aviation Airports," Information Publication A-001, May 2004, should be consulted when planning such a facility.

Other Considerations

Utilities

FBO buildings require access to water and sewer connections. This may dictate the locations of the buildings and may affect the budget.

Engineering and Construction

Engineering issues that need to be considered during planning include

- Security fence and gate locations
- Grading limitations due to the flat finished floor of the building

- Stormwater and erosion control measures may require the size of the building and adjacent impervious areas to be adjusted to fit the space available
- The grades in the area. Do not plan up to the property or lease line. Provide adequate buffer for grade tie-ins, grading limits, drainage swales, and storm sewer facilities
- The potential for jet blast
- Construction and phasing effects on existing facilities

Facility-to-Facility Relationships

An FBO building has to interact with many other facilities, the most common being the apron and automobile parking and access. The FBO building may also interact with hangars. When an FBO building and hangars interact, the FBO building must not be hidden or blocked by the hangars. The FBO building should be closer to the runway than adjacent hangars to allow a good line of sight to the airfield. A wash rack, fuel farm, or helicopter parking apron should not be close to an FBO building. A helicopter parking apron should be far enough away to reduce rotor wash near pedestrians but close enough to allow helicopter pilots easy access to the building. If FBO buildings and a GA terminal building are at the same airport, consider sufficient separation between the facilities to accommodate development around the airport.

Plan Evaluation

Exhibit 5-37 is a simple checklist to help evaluate the proposed development plan for an FBO building.

Exhibit 5-37. FBO building development plan checklist.

Criteria	Yes	No	Comment
Meets the Airport's/Tenant's needs			
Maximizes development space			
Does not interfere with other nearby or future development			
Meets community needs			
Meets local building code			
Provides space to meet local engineering requirements (i.e., stormwater and erosion control)			
Interacts well with other facilities			
Provides room for expansion			
Within the project budget			

Airport Administration Building

A separate airport administration building is not very common to GA airports, but such buildings are sometimes on larger GA airports that have multiple FBOs with their own FBO buildings. An administration building can also serve as an incubator for aviation-related businesses if additional lease space is planned for. An administration building can also provide a neutral location for community and airport events and meetings.

Questions to ask when planning an airport administration building:

- Is there an airport master plan and what does it say about the administration building?
- Can associated facilities (e.g., access road, auto parking, and apron) be developed in balance with the building?

- What functions will the building layout provide for?
- What kind of community outreach is needed to plan the building?
- Will there be an architectural theme and how will that affect layout, size, and location?
- Are there significant engineering issues (e.g., cut/fill challenges)? Drainage challenges?
- Are there existing and planned utilities to meet building needs?
- What community goals and standards will affect the building plans?
- Will construction affect other facilities on the airport and how does that affect planning?
- Will the building serve non-airport functions such as community activities?
- Will the building have attached MES facilities?
- Will the building have attached ARFF facilities?
- Will the building need to be expanded in the future?

Location

The airport administration building location should

- Provide good visibility of the airfield from the building.
- Provide safe and efficient access from primary roadways.
- Have room for adequate automobile parking.
- Not interfere with the possible expansion or construction of other airfield facilities.
- Allow room for future expansion of the building and associated parking.
- Allow easy access to utilities or areas for well water and/or a septic system.

If the administration building will serve as only an office and community building, a location that does not impede revenue-generating airside development (e.g., hangars and FBO buildings) is recommended. If the building is to have attached maintenance or ARFF facilities, a location with airside access is recommended. In determining a location, the airport must weigh the pros and cons of locating the administration building in a potential revenue-generating location versus providing good airside visibility and access.

Users & Services

When choosing a location for an administration building, it is important to determine who the users will be and what services will be provided. In addition to the airport administration, users typically include

- Aviation-Related Businesses
- Other Government Agencies
- Community Groups

Taking the proposed users of the administration building into account, the services need to be determined. The typical services in an airport administration building include

- Lobby
- Restrooms
- Vending
- Mechanical Room
- Storage Room
- Circulation
- Conference Room
- Airport Management Offices
- Office Lease Space

Size & Layout

The size of the administration building will depend on the needs of the airport and the chosen functions of the building. There are no guidelines for sizing the building, but a large enough foot print should be used with room for modifications and expansion.

It will be important to plan for the secondary space around the administration building. Secondary space would include walkways, entrance plazas, patios, landscape areas, and buffers with other buildings. If the building is to serve community functions that have large gatherings, plan for the appropriate sized parking lot.

One of the best ways to maximize development space is to plan facilities to be parallel and perpendicular to each other as much as possible. Angles create unusable space. Making an administration building as parallel or perpendicular to other facilities and airfield infrastructure also provides for safer traffic flow and expandability.

Security

Recommendations for basic security measures for an administration building include tamper-proof locks on all doors and enough lighting on all sides of the building to sufficiently illuminate the area. Additional and more expensive measures would include a monitored alarm system with cameras. If the building is part of the security perimeter, appropriate airside access security measures will need to be incorporated into the building. Consult "Security Guidelines for General Aviation Airports," Information Publication A-001, May 2004, when planning this type of facility.

Other Considerations

Utilities

Administration buildings will require access to water and sewer connections. This may dictate the locations of the building and may affect the budget.

Engineering

Engineering issues that should be considered during planning include

- Security fence and gate locations
- Grading limitations due to the flat finished floor of the building
- Stormwater and erosion control measures may require the size of the building and adjacent impervious areas to be adjusted to fit the space available
- The grades in the area. Do not plan or construct up to the property or lease line. Provide adequate buffer for grade tie-ins, grading limits, drainage swales, and storm sewer facilities
- The potential for jet blast
- Construction and phasing impacts on existing facilities

Facility-to-Facility Relationships

An administration building can be a standalone building or interact with other airport-owned facilities. The building could be constructed in the vicinity of a maintenance building or ARFF building with shared access and parking in a campus format. These facilities can also be a part of the same building to consolidate services and for economies of scale. The administration building should have easy ground access.

Plan Evaluation

Exhibit 5-38 is a simple checklist to help evaluate the proposed development plan for an airport administration building.

Exhibit 5-38. Airport administration building plan checklist.

Criteria	Yes	No	Comment
Meets the Airport's needs			
Maximizes development space			
Does not interfere with other nearby or future development			
Meets local building code			
Meets community needs			
Provides space to meet local engineering requirements (i.e., stormwater and erosion control)			
Interacts well with other facilities			
Provides room for expansion			
Within the project budget			

MES Buildings

Not all airports require a separate facility to store airport maintenance equipment. Some airports contract out the mowing and snow removal to private companies, other use municipal or county equipment used and usually housed elsewhere. If an airport has its own maintenance equipment, there are several options for storing it. Some airports leave the equipment outside, others park it in hangars, and others have dedicated storage facilities. A dedicated maintenance equipment storage (MES) building allows an airport to protect investment in equipment and may free potential lease space in aircraft hangars to generate revenue.

Questions to ask when planning a MES building:

- Is there an airport master plan and what does it say about the MES building?
- Can associated facilities (e.g., access road and auto parking) be developed in balance with the building?
- What functions will the building layout provide for?
- What kind of community outreach is needed to plan the building?
- Will there be an architectural theme and how will that affect layout, size, and location?
- Are there significant engineering issues such as cut/fill challenges? Drainage challenges?
- Are there existing and planned utilities to meet building needs?
- What community goals and standards will affect the building plans?
- Will construction affect other facilities on the airport and how does that affect planning?
- Will the building have attached Administrative offices?
- Will the building have attached ARFF facilities?
- How much equipment needs to be stored?
- Will the facility need to be expanded in the future?
- Does the facility need both airside and landside access?
- Will maintenance be performed on the equipment? If so, what type and how will this affect layout?

Location & Orientation

AC 150/5220-18A, "Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials" has good information for snow removal equipment (SRE) buildings that can be applied to MES buildings. Similar to the SRE building, the MES building should be located

- So that maintenance equipment activities do not interfere with aircraft operations
- So maintenance equipment is not required to cross large amounts of airfield pavement thereby increasing the chances of FOD
- So that employees do not have to cross active airfield pavements to reach the facility
- So that it does not interfere with the possible expansion or construction of other airfield facilities
- To meet AC 150/5300-13a and FAR Part 77 guidelines
- To allow for future expansion

In addition to location, the orientation of a MES building can be important. A MES building should be oriented so that

- In heavy snow regions, the doors are parallel to the primary wind direction to help prevent snow buildup in front of the doors
- In regions that have ice and snow, the doors do not face north blocking the apron in front of the door from the sun
- In hot and sunny regions, the doors do not face south such that the inside of the hangar does not receive direct sunlight in the afternoons heating up the building. This is especially important if maintenance is being performed
- The primary wind direction is not into the building

Depending on the size of the airport, activity level, and personnel assigned to maintenance, it may be beneficial to co-locate the MES building with the fuel farm and possibly the airfield electrical vault.

Size & Layout

The building size will depend on many things. In determining the building size, the following questions need to be answered:

- How much equipment needs to be stored?
- What type of equipment is to be stored?
- Can the facility also be used for ARFF equipment?
- Will the facility store snow removal equipment?
- Will maintenance be performed on the equipment? If so, what type?
- Does the facility need office and restroom facilities?
- What type of utilities will be needed, including internet for weather?

Exhibit 5-39 presents planning guides for the size of the facility based on the size of the airport. These numbers are just a starting point. Airports with significant snow and larger runways will probably need a larger facility to accommodate the snow removal equipment along with grass cutting and other maintenance vehicles. Airports may also need additional vehicle bays for use as a maintenance bay or for ARFF equipment.

Exhibit 5-40 depicts examples of MES buildings for all three size airports with side-by-side vehicle bays. Exhibits 5-41 and 5-42 depict examples of MES buildings for the medium and large size airports with stacked vehicle bays. The support facilities shown are a general layout and description only. Each airport should decide what facilities they need and their sizes. Coordination with the FAA for eligibility of space is recommended. Exhibit 5-43 depicts a building layout with the footprints of maintenance equipment including trucks, tractors, and attachments. The building also has a heated maintenance bay for cold weather climates.

Exhibit 5-39. MES building sizing.

Areas	Small (less than 250 acres)	Medium (between 250 and 500 acres)	Large (between 500 and 750 acres)
Equipment Storage	1,200 - 1,600 sf (2 bays)	2,400 - 3,200 sf (4 bays)	3,600 - 4,800 sf (6 bays)
Support	0 sf	600 - 800 sf (1 bay)	1,200 - 1,600 sf (2 bays)
Total	1,200 - 1,600 sf (2 bays)	3,000 - 4,000 sf (5 bays)	4,800 - 6,400 sf (8 bays)

Note: Airports larger than 750 acres should refer to AC 150/5220-18A for guidance
Source: Delta Airport Consultants, Inc.

Exhibit 5-40. MES building with side-by-side vehicle bays.

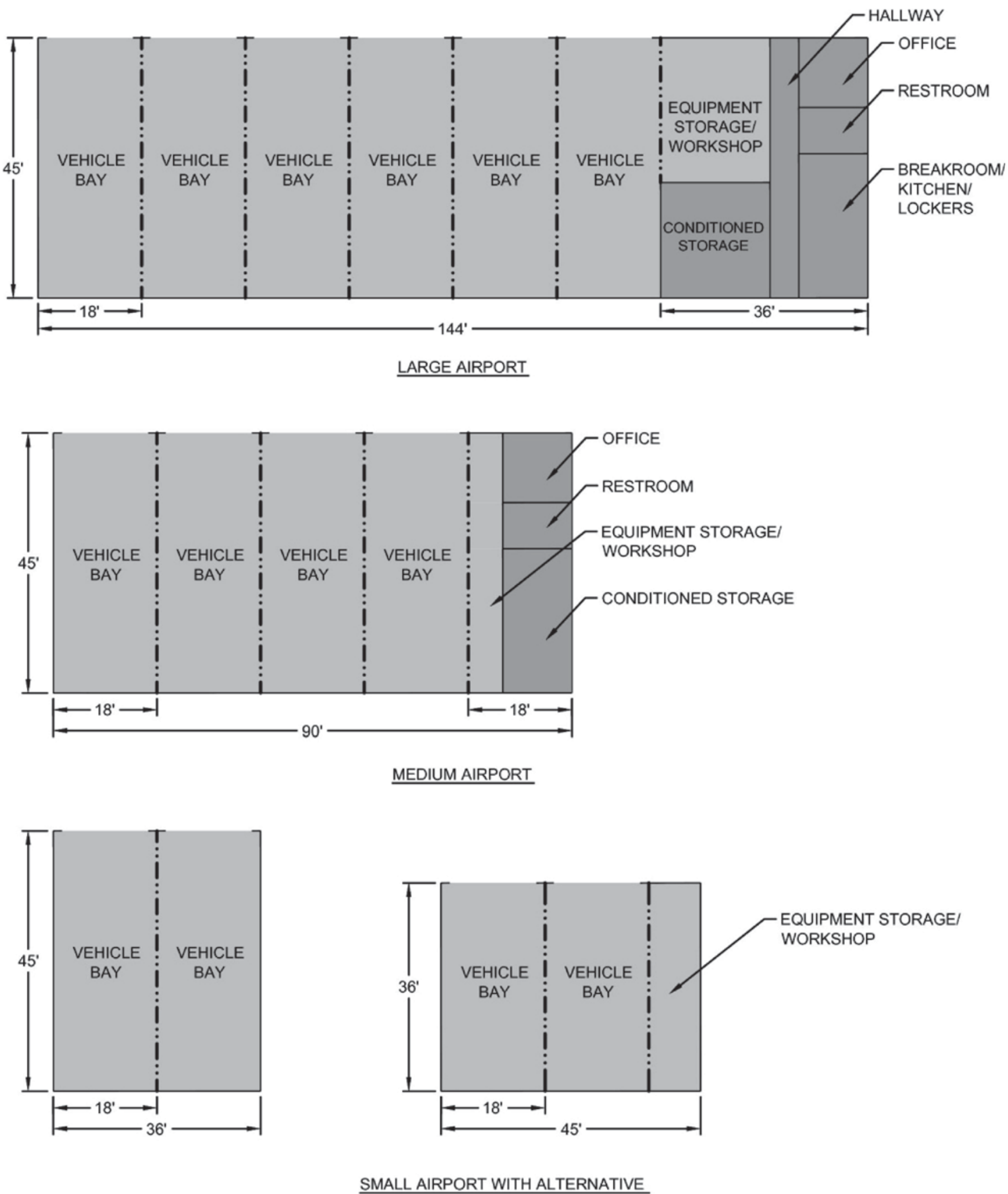
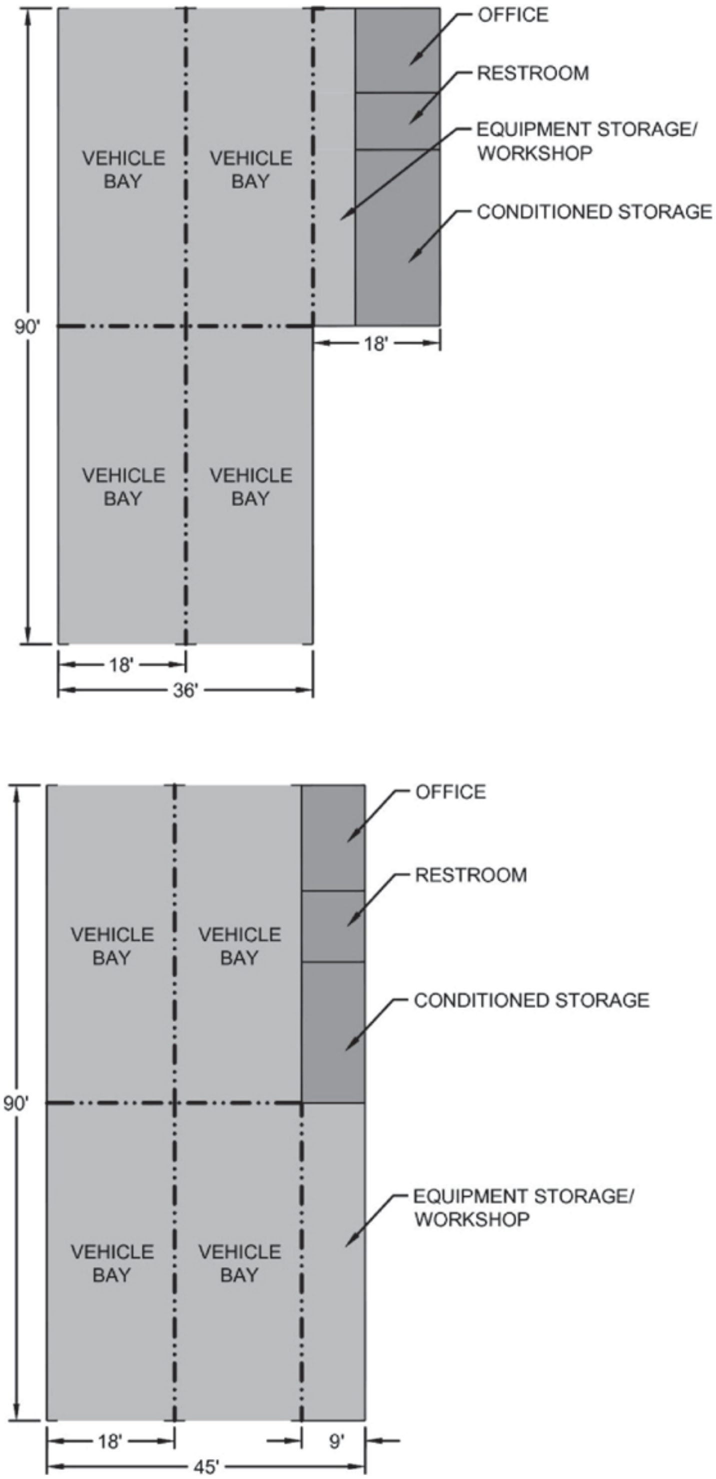
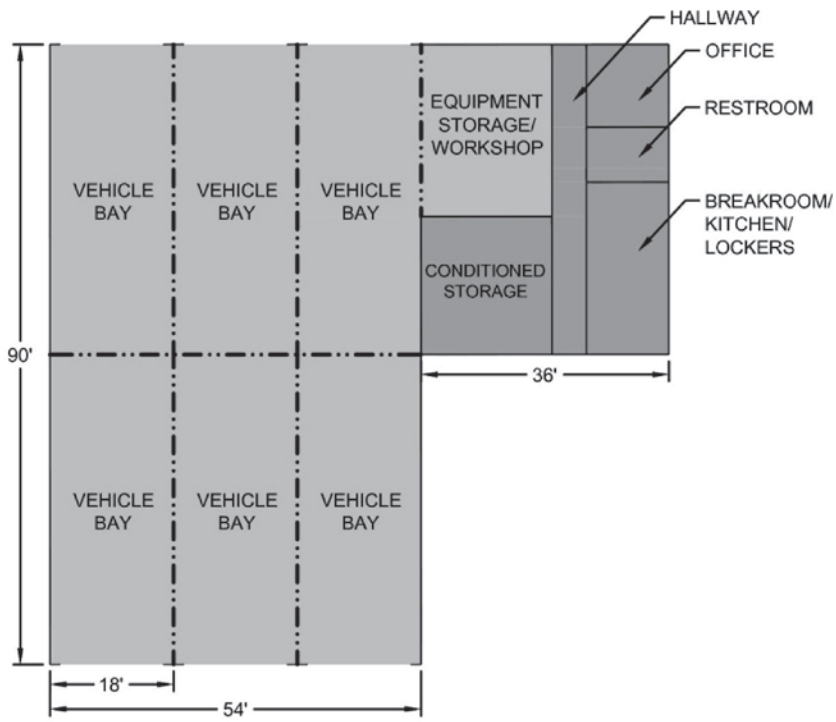


Exhibit 5-41. MES buildings with stacked vehicles bays for medium airports.



Source: Delta Airport Consultants, Inc.

Exhibit 5-42. MES buildings with stacked vehicles bays for large airports.



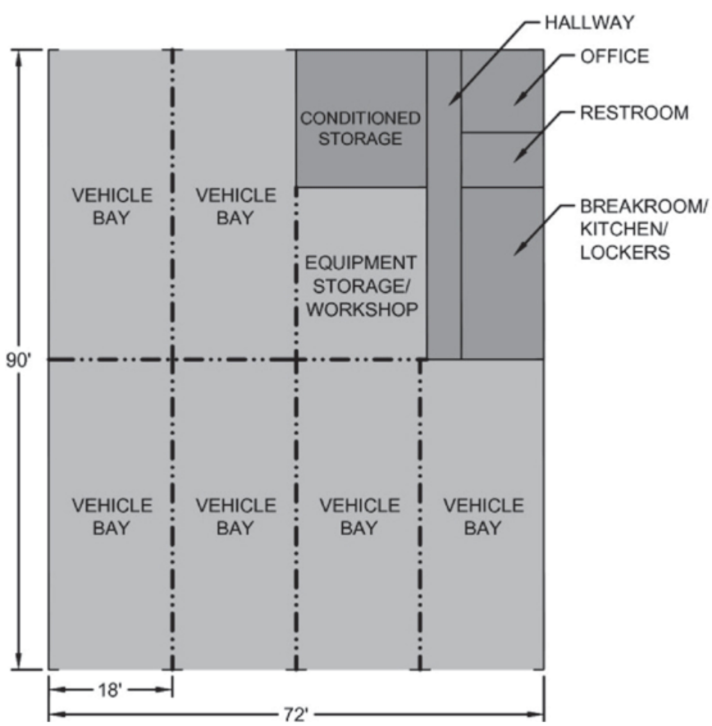
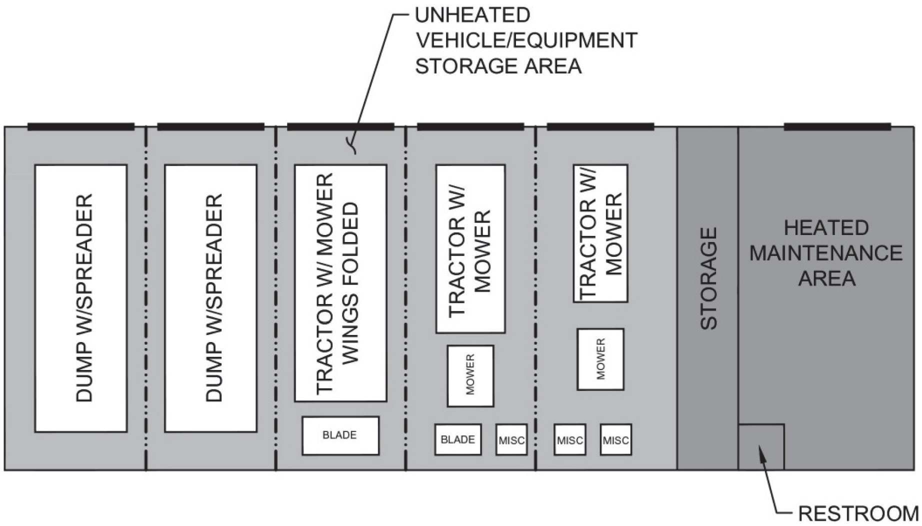


Exhibit 5-43. MES buildings with sample equipment layout.



Source: Delta Airport Consultants, Inc.

One of the best ways to maximize development space is to plan facilities to be parallel and perpendicular to each other as much as possible. Angles create unusable space. Making a MES building as parallel or perpendicular to other facilities and airfield infrastructure also provides for safer traffic flow and expandability.

Security

Recommendations for basic security measures for a MES building include tamperproof locks on all doors and enough lighting on all sides of the building to sufficiently illuminate the area. Additional and more expensive measures would include a monitored alarm system and cameras. If the building is part of the security perimeter, appropriate airside access security measures will need to be incorporated into the building. Consult the TSA's "Security Guidelines for General Aviation Airports," Information Publication A-001, May 2004, when planning this type of facility.

Other Considerations

In addition to the actual building itself, the space around the building needs to be considered. Large pieces of maintenance equipment often require large maneuvering space due to the size of the unit or other attachments. A large paved or gravel driveway should be provided in front of the vehicle bays. The area should be large enough to be able to pull the vehicle out and remove or attach additional equipment.

Utilities

MES buildings may require access to water and sewer connections. This may dictate the locations of the building and may affect the budget.

Engineering and Construction

Engineering issues that need to be considered during the planning process include

- Security fence and gate locations
- Grading limitations due to the flat finished floor of the building
- Stormwater and erosion control measures may require the size of the building and adjacent impervious areas to be adjusted to fit the space available

- Grades in the area. Do not plan or construct up to the property or lease line. Provide adequate buffer for grade tie-ins, grading limits, drainage swales, and storm sewer facilities
- The potential for jet blast
- Construction and phasing impacts on existing facilities
- Grades around the building and access to the airfield for the equipment

The airport should consult local building codes during design to determine building requirements.

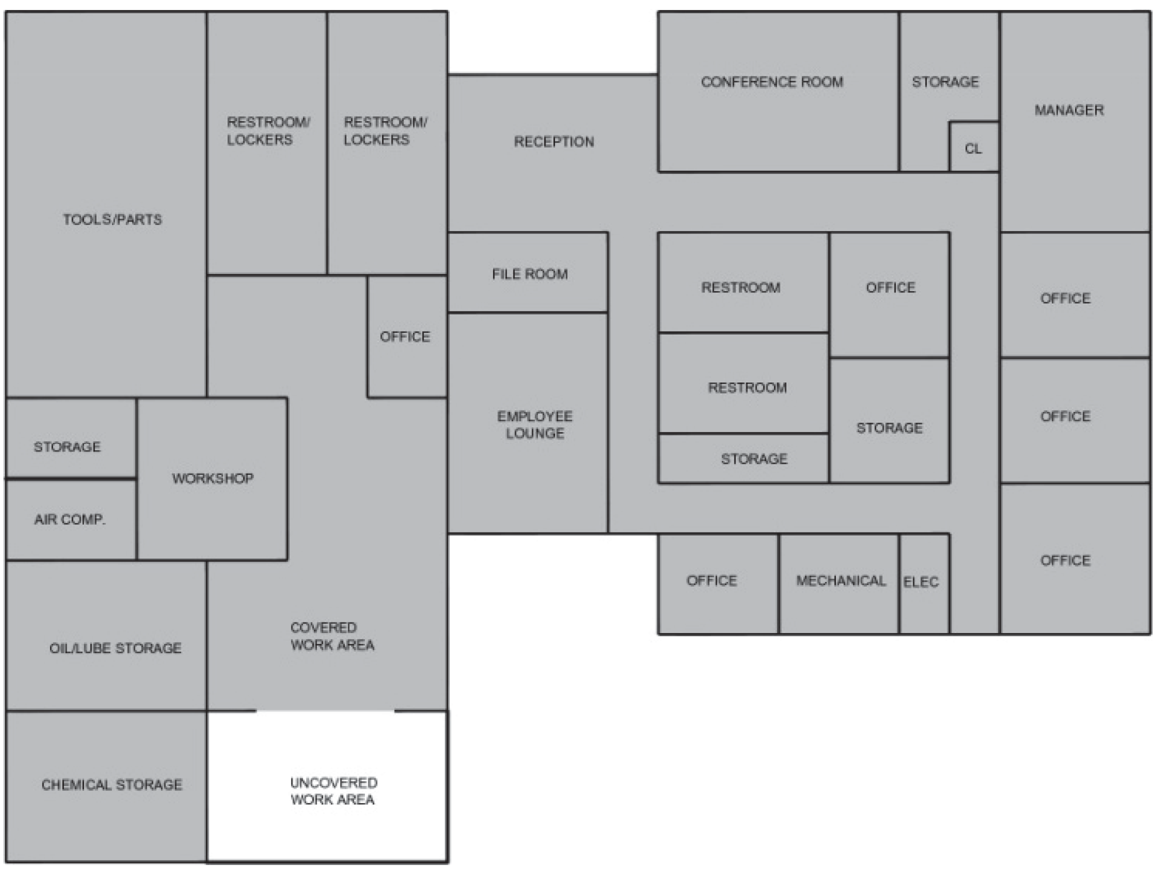
Facility-to-Facility Relationships

A MES building can be a standalone building or interact with other airport-owned facilities. The building could be constructed near an airport administration building or ARFF building with shared access and parking in a campus format. These facilities can also be a part of the same building to consolidate services and for economies of scale. Exhibit 5-44 illustrates an administration building with an attached maintenance facility. This illustration is based on the Opa-locka Executive Airport administrative building.

The MES building could also be near the fuel farm or wash rack to share common utilities. Locating the MES building with the fuel farm, airfield electrical vault, and emergency generator could also reduce response time to problems and access to tools and equipment in case of an emergency.

The benefits of locating or co-locating the MES building with other facilities needs to be weighed against the possible effect on prime airside real estate and potential revenue-producing facilities.

Exhibit 5-44. Sample administration building with attached MES building.



Source: Delta Airport Consultants, Inc. & Opa-locka Airport Authority

Plan Evaluation

Exhibit 5-45 provides a simple checklist to help evaluate the proposed development plan for a MES building.

Exhibit 5-45. MES building development plan checklist.

Criteria	Yes	No	Comment
Meets the Airport's needs			
Maximizes development space			
Does not interfere with other nearby or future development			
Does not impact or restrict taxilanes or taxiways			
Meets local building code			
Meets FAA design criteria			
Provides space to meet local engineering requirements (i.e., stormwater and erosion control)			
Interacts well with other facilities			
Provides room for expansion			
Within the project budget			

Automobile Parking and Access

Providing access and parking areas for airfield facilities should be integral to planning each of the facilities. Access should be safe and efficient. Good visibility all along the access road and in the parking area is very important. Providing adequate safe parking will also create a positive impression of the facility. Not all facilities will need or require parking. In many instances, the facility parking will depend on the local guidelines.

Questions to ask when planning automobile parking and access:

- How much parking is needed by facility type?
- Will the parking area need to be expanded in the future?
- What are the local parking requirements?
- What utilities are needed?
- What are the local emergency services requirements?
- Will the parking be used by users of other facilities?
- Is/are the access roads easy to find?
- What type of vehicles are the access roads going to accommodate?
- Are there significant engineering issues (e.g., cut/fill challenges)? Drainage challenges?
- Will construction affect other facilities on the airport and how does that affect planning?

Location

Automobile parking should

- Provide safe and easy ingress and egress for the vehicles expected to use the spaces.
- Be close to the facility they are serving.
- Ensure that employees do not have to cross active airfield pavements to reach their destination.
- Ensure that pedestrians do not have to cross other roads to reach their destination.
- Not interfere with the possible expansion or construction of other airfield facilities.
- Ensure that vehicles do not have to back out of the space directly into a primary road.

An access road should

- Provide a safe and as direct as possible access to the proposed destination.
- Avoid restricting future airfield development.
- Provide access to as many different facilities as possible.

Size & Layout

Once a location is chosen, the size of the parking lot and the number of parking spaces will need to be determined. The size of each parking space and the number of spaces will most likely be determined by local parking guidelines. Very few state aviation system plans have guidelines on automobile parking. The states that do generally recommend one space per based aircraft plus a percentage for employees and visitors.

If there are no local or state guidelines, a typical parking space size for planning purposes is 20 feet long and 10 feet wide. A driving lane between rows of parking is typically 25 feet wide. These are the dimensions that will be used for the purposes of this Guidebook.

Exhibit 5-46 presents dimensions for minimum depths for different configurations with an accompanying exhibit. The depths include a 5-foot buffer for signs, light poles, fences, bollards, and other parking accessories.

Exhibit 5-46. Parking lot depth types.

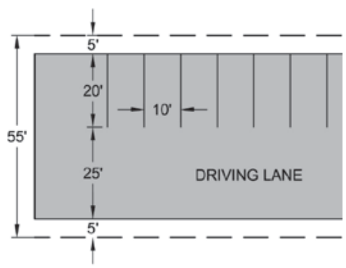
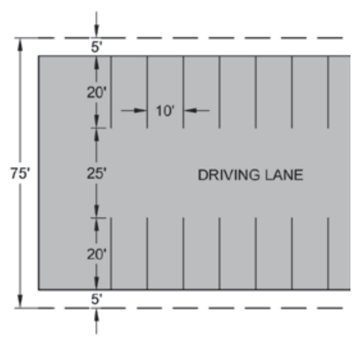
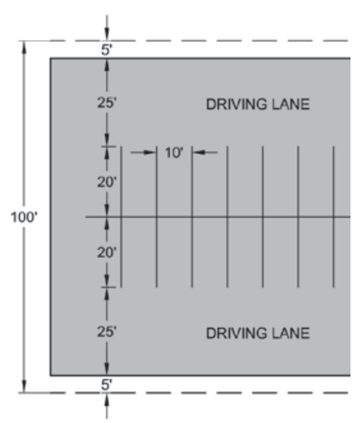
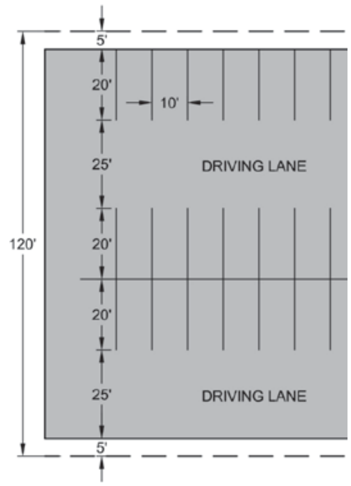
Configuration Type	Figure	Description
A		1 Single row of spaces 1 Single driving lane 55 foot depth
B		2 single rows of spaces 1 Single driving lane 75 foot depth
C		1 Double row of spaces 2 driving lanes 100 foot depth

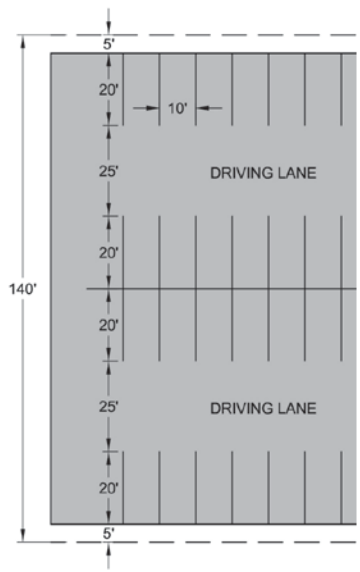
Exhibit 5-46. (Continued).

D



1 Single row of spaces
1 Double row of spaces
2 driving lanes
120 foot depth

E



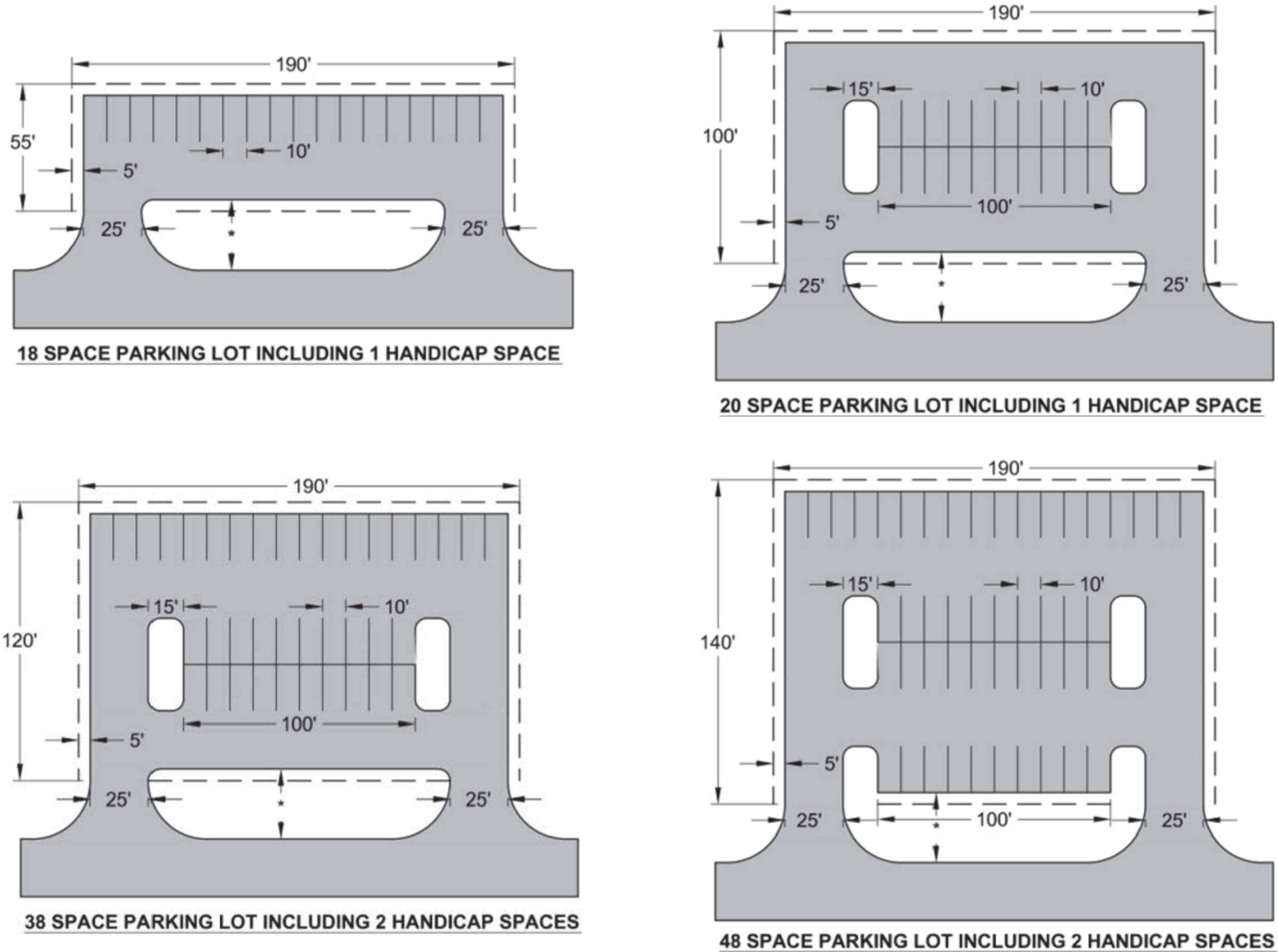
2 Single row of spaces
1 Double row of spaces
2 driving lanes
140 foot depth

Source: Delta Airport Consultants, Inc.

These depths do not include access drives or offsets from the primary roadways. For parking adjacent to hangars, check local requirements and those in the International Building Code (IBC). IBC requires that no public way (e.g., road, parking, and sidewalk) be within 30 feet of a hangar unless the hangar has a 2-hr rated firewall. Consult your local fire marshal and building code official for this and other unique parking requirements. For this Guidebook, parking spaces and driving lanes will be no closer than 30 feet to a hangar.

One of the best ways to maximize development space is to plan facilities to be parallel and perpendicular to each other as much as possible. Angles create unusable space. Making automobile parking as parallel or perpendicular to other facilities and infrastructure also provides for safer traffic flow and expandability. Exhibit 5-47 depicts several examples of parking lot layouts.

Exhibit 5-47. Sample parking lot layouts.



Note: * = Distance as needed to meet local guidelines or allow a radius to accommodate the expected vehicle traffic. (Recommend not less than 25 feet)
Source: Delta Airport Consultants, Inc.

Security

Recommendations for basic security measures for a parking lot are to provide enough lighting to sufficiently illuminate the area. Additional and more expensive measures would include security cameras. Consult the TSA's "Security Guidelines for General Aviation Airports," Information Publication A-001, May 2004, when planning this type of facility.

Other Considerations

Number of Spaces

When planning for automobile parking areas, a rough idea of the number of parking spaces is needed. As noted in Exhibit 5-48, local codes and ordinances should be consulted first to determine the number of required parking spaces. If there are no local requirements or additional guidance is needed, Exhibit 5-48 provides general rules of thumb for the number of parking spaces at the GA facilities addressed in this Guidebook.

Exhibit 5-48. Recommended number of parking spaces per type of facility.[1]

Box Hangar (storage only)	
Per local parking requirements 1 space per 1,000 sf of hangar floor space (5 minimum)	or
Sample: a 6,400 sf hangar would need 7 spaces	
Box Hangar (with office or maintenance space)	
Per local parking requirements 1 space per 1,000 sf of hangar floor space (5 minimum) 1 space per 200 sf of office space (5 minimum) 1 space per 750 sf of maintenance/shop space (5 minimum)	or and and
Sample: a 10,000 sf hangar (10) with 2,000 sf of office (10) would need 20 spaces	
T-Hangar	
Per local parking requirements 1 space for 50% of units	or
Sample: a 12 unit t-hangar would need 6 spaces	
GA Terminal Building/ FBO Building[2]	
Per local parking requirements	or
2.5 spaces per peak-hour operations (operations from the master plan)	and
1 space per 200 sf of office space (5 minimum)	
Sample: an airport with 15 peak-hour operations (38) and 1,200 sf of offices (6) would need 44 spaces	
Airport Administrative Building[2]	
Per local parking requirements	or
1 space per 200 sf of office space (5 minimum)	
Sample: a 4,000 sf administration building would need 20 spaces	
MES Building	
Per local parking requirements	or
1 space per vehicle bay	and
1 space per 750 sf of maintenance/shop space (5 minimum)	
Sample: a MES building with four bays (4) and 810 sf (5) of shop space would need 9 spaces	
Based Aircraft Apron	
Per local parking requirements	or
1 space for 50% of based tie-down spaces	
Sample: an apron with 10 tie-down spaces would need 5 spaces	

Notes: 1. These are general planning numbers only. The local guidelines should be consulted to determine the actual number of parking spaces required.
2. The number of parking spaces should be increased as appropriate if the buildings include space for community events.

Source: Delta Airport Consultants, Inc.

For "resort" airports, providing additional long-term parking of vehicles for infrequent users should be considered.

As an example, planning for a shared parking lot for the GA terminal building, box hangar with maintenance, and t-hangar in Exhibit 5-48, would require 70 parking spaces.

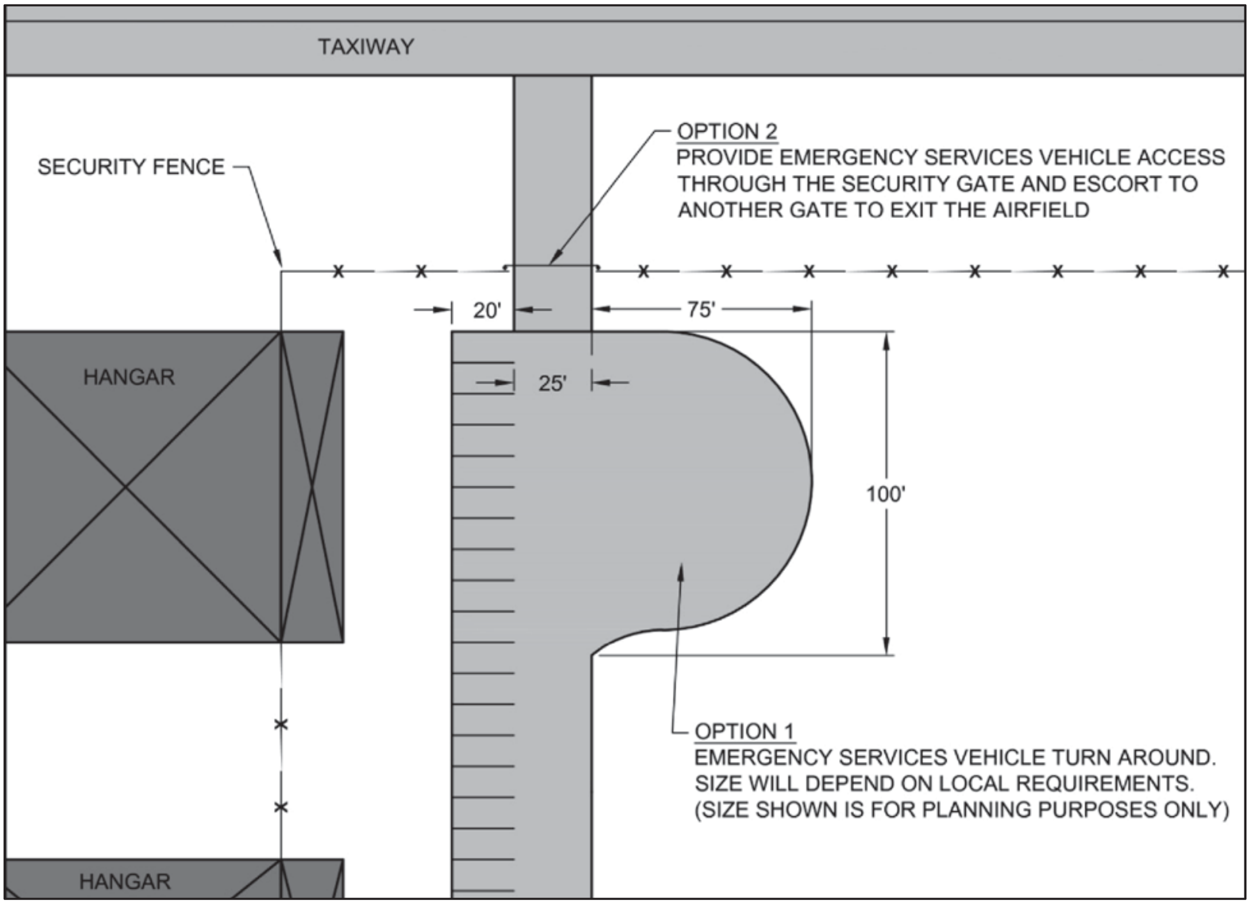
When determining the number of parking spaces, remember to follow the current federal guidelines for handicapped parking requirements.

Engineering and Construction

Engineering issues that need to be considered during the planning process include

- Construction and phasing impacts on existing facilities.
- Stormwater and erosion control measures may require the size of the parking to be adjusted to fit the space available.
- The grades in the area. Do not plan up to the property or lease line. Provide adequate buffer for grade tie-ins, grading limits, drainage swales, and storm sewer facilities.
- If lighting is required, make sure there is access to the appropriate electrical power. Also make sure that space is provided in the interior of the parking lot as well as the perimeter for the light poles.

Exhibit 5-49. Dead end parking lots for emergency services vehicles.



Source: Delta Airport Consultants, Inc.

- Check the local landscaping requirements and plan for adequate green space.
- If the parking is for a public-use facility (e.g., a terminal building), consider providing unobstructed access to the facility from the parking lot via a raised walkway or central plaza.
- The potential for jet blast.
- Consider providing overflow parking for special events (e.g., airshows) adjacent to the access roads in fields or other turfed areas.

Be aware of any local design codes for parking lots and emergency services vehicles when planning. Many localities do not permit deadend parking lots that require emergency services vehicles to back up. Exhibit 5-49 provides options if this condition is required.

Facility-to-Facility Relationships

Every GA facility discussed in this Guidebook will interact with either automobile parking or vehicle access. For the most part, parking for any publicly accessible building with office space will require parking per the local guidelines. The interaction with each facility has been discussed in each individual section.

Plan Evaluation

Exhibit 5-50 is a simple checklist to help evaluate the proposed development plan for automobile parking and access.

Exhibit 5-50. Automobile parking and access plan checklist.

Criteria	Yes	No	Comment
Meets the Airport's needs			
Maximizes development space			
Does not interfere with other nearby or future development			
Does not impact or restrict taxilanes or taxiways			
Provides space to meet local engineering requirements (i.e., stormwater and erosion control)			
Meets local parking regulations			
Interacts well with other facilities			
Provides room for expansion			
Within the project budget			

APPENDIX A

Abbreviations and Terms

Abbreviations

AC	Advisory Circular
ACIP	Airport Capital Improvement Plan
AIP	Airport Improvement Program
ALP	Airport Layout Plan
ACOE	Army Corps of Engineers
ADG	Airplane Design Group
ARC	Airport Reference Code
ARFF	Aircraft Rescue and Fire Fighting
ARTCC	Air Route Traffic Control Center
ATCT	Air Traffic Control Tower
AWOS	Automated Weather Observation Station
AZD	Airport Zoning District
BCA	Benefit-Cost Analysis
BMP	Best Management Practice
BRL	Building Restriction Line
CIP	Capital Improvement Plan
dBA	A-weighted Decibels
DNL	Day-night Average Noise Levels
DOD	Department of Defense
EA	Environmental Assessment
E&SC	Erosion and Sediment Control
FAR	Federal Aviation Regulation
FBO	Fixed-Base Operator
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GA	General Aviation
GPS	Global Positioning System
GSE	Ground Service Equipment
IFR	Instrument Flight Rules
ILS	Instrument Landing System
MP	Master Plan
NAVAIDs	Navigational Aids
NDB	Non-directional Radio Beacon
NEPA	National Environmental Policy Act
NPIAS	National Plan of Integrated Airport Systems
OFA	Object Free Area

OFZ	Obstacle Free Zone
RPZ	Runway Protection Zone
RDC	Runway Design Code
RRC	Runway Reference Code
RSA	Runway Safety Area
TAF	Terminal Area Forecast
TDG	Taxiway Design Group
TLOFA	Taxilane Object Free Area
TOFA	Taxiway Object Free Area

Terms

Access Taxiway: A taxiway that provides access to a particular location or area.

Active Based Aircraft: Aircraft that have a current airworthiness certificate and are based at an airport.

Actual Runway Length: The length of full width, usable runway from end to end or full strength pavement where those runways are paved.

Administration Building: A building or buildings accommodating airport administration activity and public facilities for itinerant and local flying, usually associated with GA fixed-base operations.

Administration Space: The space including, but not limited to, space for offices, cafeterias, conference rooms, lobbies, waiting rooms, garages, parking lots.

Advisory Circular (AC): A series of FAA publications consisting of all nonregulatory material of a policy, guidance, and informational nature.

Aeronautical Chart: A map representing a portion of the earth, made especially for use in air navigation.

Air Cargo: All commercial air express and air freight except air mail and air parcel post.

Air Carrier Airport: An airport (or runway) designated by design and/or use for air carrier operations.

Air Carrier—All Cargo: A certificated route air carrier authorized to perform scheduled air freight, express, and mail transportation service as well as the conduct of nonscheduled operations (which may include passengers over specified routes).

Air Carrier—Certificated Route: An air carrier holding a Certificate of Public Convenience and Necessity issued to conduct scheduled services over specified routes and a limited number of nonscheduled operations.

Air Carrier—Commuter: An air taxi operator which: (1) performs at least five round trips per week between two or more points and publishes flight schedules that specify the times, days of the week, and places between which such flights are performed; or (2) transports mail by air under a current contract with the U.S. Postal Service.

Air Carrier—Intrastate: An air carrier licensed by a state to operate wholly within its borders but not permitted to carry interline passengers from out of state.

Aircraft Approach Category: A grouping of aircraft based on 1.3 times their stall speed in their landing configuration at their maximum certificated landing weight.

Aircraft Design Group (ADG): A grouping of airplanes based on wingspan.

Aircraft Operations: The airborne movement (landing or taking off) of aircraft. There are two types of operations—local and itinerant.

1. Local operations are performed by aircraft that:
   a. Operate in the local traffic pattern or within sight of the airport.
   b. Are known to be departing for, or arriving from, flight in local practice areas within a 20-mile radius of the airport.
   c. Execute simulated instrument approaches or low passes at the airport.
2. Itinerant operations are all aircraft operations other than local operations.

Aircraft Rescue and Fire Fighting (ARFF): The aircraft rescue and firefighting capability required at airports under FAR Part 139.

Aircraft Tie-down: Positions on the ground surface available for securing aircraft.

Airfield Capacity (Hourly): The maximum number of aircraft operations (landings or takeoffs) that can take place on an airfield in one hour under specific conditions.

Air Freight: A system or service set up for the carrying of freight by air.

Airman's Meteorological Information (AIRMET): An in-flight weather advisory concerning weather phenomena of less severity than that covered by SIGMETs, which are potentially hazardous to certain aircraft, e.g., those having limited equipment, instrumentation, or pilot qualifications. These advisories cover moderate icing and turbulence, winds of 40 knots or more within 2,000 feet of the surface, and the initial onset of visibilities less than 2 miles or ceilings less than 1,000 feet.

Air Navigation Facility (NAVAID): Any facility used or designed for use as an aid to air navigation.

Airport: An area of land or water used or intended to be used for the landing and takeoff of aircraft, including its buildings and facilities. (FAR Part 1)

Airport Advisory Service (AAS): A service provided by flight service stations at airports not served by a control tower. This service consists of providing information to landing and departing aircraft concerning wind direction and velocity, favored runway, altimeter setting, pertinent known traffic, pertinent known field conditions, airport taxi routes and traffic patterns, and authorized instrument approach procedures.

Airport Beacon: A navigational aid emitting alternating white and green flashes to indicate a lighted airport or white flashes only for an unlighted airport.

Airport Elevation: The highest point on an airport's usable runways expressed in feet above mean sea level (MSL).

Airport Environs: The area surrounding an airport considered to be directly affected by the presence and operation of the airport.

Airport Imaginary Surfaces: Imaginary surfaces established at an airport for obstruction determination purposes.

Airport Improvement Program (AIP): A program administered by the FAA to provide financial grants-in-aid for airport planning, airport development projects, and noise compatibility programs. The program was established through the Airport and Airway Improvement Act of 1982, which was incorporated as Title V of the Tax Equity and Fiscal Responsibility Act of 1982 (P.L. 97-248).

Airport Land Use Plan: A generalized plan depicting proposed land uses within the airport boundary. The land use plan is a required element of an airport master plan.

Airport Layout Plan (ALP): The plan for an airport showing the layout of existing and proposed airport facilities and structures.

Airport Master Plan: Appropriate documents and drawings concerning the development of a specific airport from a physical, economic, social, and political jurisdictional perspective. The airport layout plan is a part of this plan.

Airport Operation: A landing or a takeoff at an airport. (A low approach below traffic pattern altitude or a touch-and-go operation are counted as both a landing and a takeoff; i.e., two operations.)

Airport Sponsor: A public agency or tax-supported organization, such as an airport authority, authorized to own and operate an airport, obtain property interests, obtain funds, and be legally, financially, and otherwise able to meet all applicable requirements of current laws and regulations.

Airport System Planning: The developing information and guidance to determine the extent, type, nature, location, and timing of airport development needed to establish a viable and balanced system of public airports.

Airports Closed to the Public: An airport not available to the public without permission from the owner.

Airports Open to the Public: An airport open to the public without prior permission and without restrictions within the physical capacities of available facilities.

Air Traffic: Aircraft operating in the air or on an airport surface, exclusive of loading ramps and parking areas. (FAR Part 1)

Air Traffic Control (ATC): A service operated by appropriate authority to promote the safe, orderly, and expeditious flow of air traffic. (FAR Part 1)

Approach Area: The defined area over which landing and takeoff operations are made.

Approach Surface: An imaginary surface longitudinally centered on the extended centerline of the runway, beginning at the end of the primary surface and rising outward and upward to a specified height above the established airport elevation.

Apron: A defined area, on a land airport, intended to accommodate aircraft for purposes of loading or unloading passengers or cargo, refueling, parking, or maintenance.

Avigation Easement: A grant of property interest in land over which a right of unobstructed flight in the airspace is established.

Bearing: The horizontal direction of an object or point, measured as an angle, usually clockwise, from true or magnetic north through 360 degrees.

Blast Fence: A barrier used to divert or dissipate jet blast or propeller wash.

Building Restriction Line (BRL): A line shown on the airport layout plan beyond which airport buildings must not be positioned to limit their proximity to aircraft movement areas and impact on airport imaginary surfaces.

Bypass Taxiway: A taxiway adjacent to an area that accommodates moving or parked aircraft specifically designed to achieve efficient aircraft passing movements.

Capital Improvement Plan (CIP): A multiyear (sometimes single-year) schedule of capital expenditures for construction or equipment at an airport.

Compass Calibration Pad: An airport facility for calibrating an aircraft compass.

Conical Surface: A surface extending from the periphery of the horizontal surface outward and upward at a slope of 20:1 as prescribed by FAR Part 77.

Critical Aircraft: In airport design, the aircraft that controls one or more design items such as runway length, pavement strength, lateral separation, etc., for a particular airport. The same aircraft may not be critical to all design items.

Crosswind: A wind blowing across the line of flight of an aircraft.

Crosswind Runway: A runway that provides for wind coverage not adequately provided by the primary runways.

Environmental Assessment (EA): A statement prepared under the requirements of the National Environmental Policy Act of 1969 (NEPA), Section 102(2) (c). The EA represents a federal agency's evaluation of the effects of a proposed action on the environment. Regulations relating to the preparation of an EA are published in FAA Order 5050.4A, *Airport Environmental Handbook.*

Exit Taxiway: A taxiway used as an exit from a runway to another runway, apron, or other aircraft operating area.

FAR PART 77: Federal Aviation Regulations Part 77, *Objects Affecting Navigable Airspace.* Establishes standards for determining obstructions and conducting aeronautical studies to determine the potential effects of obstructions on aircraft operations. Objects are considered to be obstructions to air navigation according to FAR Part 77 if they exceed certain heights or penetrate certain imaginary surfaces established in relation to airports. Objects classified as obstructions are subject to an aeronautical study by the FAA to determine their potential effects on aircraft operations.

FAR PART 91: Federal Aviation Regulations Part 91, *General Operating and Flight Rules.* On September 25, 1991, the FAA issued an amendment to FAR Part 91 (14CFR91) in conformance with the requirements of the Airport Noise and Capacity Act of 1990. The amendment to the aircraft operating rules requires a phased transition to an all Stage 3 fleet operating in the 48 contiguous United States and the District of Columbia by December 31, 1999. The amendment places a cap on the number of Stage 2 aircraft allowed to operate in the United States and provides for a continuing reduction in the population exposed to noise from Stage 2 aircraft.

FAR PART 150: Federal Aviation Regulations Part 150, *Airport Noise Compatibility Planning.* An FAR Part 150 Program is an FAA-assisted study designed to increase the compatibility of land and facilities in the areas surrounding an airport that are most directly affected by operation of the airport. The specific purpose is to reduce the adverse effects of noise as much as possible by implementing both on-airport noise abatement measures and off-airport noise mitigation programs. The basic products of an FAR Part 150 program typically include (1) noise exposure maps for the existing condition and for 5 years in the future; (2) workable on-airport noise abatement measures, such as preferential runway use programs, new or preferential flight tracks, and curfews; (3) off-airport noise mitigation measures (land use control programs and regulations), such as land acquisition, soundproofing, or special zoning; (4) an analysis of the costs and the financial feasibility of the recommended measures; and (5) policies and procedures related to the implementation of on- and off-airport programs. A community involvement program is carried on throughout all phases of program development.

FAA: The agency of the U.S. Department of Transportation charged with (1) regulating air commerce to promote its safety and development; (2) achieving the efficient use of navigable airspace of the United States; (3) promoting, encouraging, and developing civil aviation; (4) developing and operating a common system of air traffic control and air navigation for both civilian and military aircraft; and (5) promoting the development of a national system of airports.

General Aviation: That portion of civil aviation that encompasses all aviation except air carriers and large aircraft commercial operators.

General Aviation Aircraft: All civil aircraft except those used by air carriers.

Glide Slope (GS): An ILS navigation facility providing vertical guidance for aircraft during approach and landing.

Holding Apron: (see holding bay)

Holding Bay: An area where aircraft can be held, or bypassed, to facilitate efficient ground traffic movement.

Holding Point: A designated point or location, identifiable by the pilot by visual reference to the ground or by NAVAIDs, near which he or she maneuvers the aircraft while awaiting further clearance.

Instrument Approach Runway: A runway served by an electronic aid providing directional guidance adequate for a straight-in approach.

Instrument Approach System: An air navigation system used to guide aircraft to a safe landing beginning at an initial approach point and ending at a point near enough to the ground to permit a visual landing.

Instrument Flight Rules (IFR): FAR rules that govern the procedures for conducting instrument flight. (FAR Part 91)

Instrument Landing System (lLS): A system that provides the lateral, longitudinal, and vertical guidance necessary for a landing.

Instrument Operation: An aircraft operation in accordance with an IFR flight plan or an operation where IFR separation between aircraft is provided by a terminal control facility or air route traffic control center.

Instrument Runway: A runway equipped with electronic and visual navigation aids and for which a straight-in (precision or nonprecision) approach procedure has been approved or is planned.

Land Use Compatibility Assurance: Documentation provided by an airport sponsor to the FAA. The documentation is related to an application for an airport development grant. Its purpose is to assure that a reasonably appropriate action, including the adoption of zoning laws, has been taken or will be taken to restrict the use of land adjacent to the airport or in the immediate vicinity of the airport. Such uses are limited to activities and purposes compatible with normal airport operations, including the landing and takeoff of aircraft.

Large Airplane: An airplane of more than 12,500 pounds maximum certificated takeoff weight.

NAVAID: Any facility used in aid of air navigation, including lights, equipment for disseminating weather information, signaling, radio direction finding, or radio or other electronic communication, and any other structure or mechanism having a similar purpose for guiding or controlling flight in the air or the landing or takeoff of aircraft.

Nonprecision Instrument Runway: A runway having only horizontal navigation guidance for which a straight-in, nonprecision instrument approach procedure has been approved.

100-Year Floodplain: An area subject to flooding with an annual frequency of 1:100.

Object Free Area (OFA): A two-dimensional ground area surrounding runways, taxiways, and taxilanes which is clear of objects except for objects whose location is fixed by function.

Obstacle Free Zone (OFZ): The airspace centered about the runway that is clear of object penetrations other than frangible NAVAIDS.

Primary Surface: A rectangular surface longitudinally centered about a runway. Its width is a variable dimension and it usually extends 200 feet beyond each end of the runway. The elevation of any point on this surface coincides with the elevation of its nearest perpendicular point on the runway centerline or extended runway centerline.

Reliever Airport: An airport to serve GA aircraft that might otherwise use a congested airport served by air carriers.

Runway Orientation: The magnetic bearing of the centerline of the runway.

Runway Protection Zone (RPZ): An area (formerly referred to as the clear zone) used to enhance the safety of aircraft operations.

Runway Safety Area (RSA): A defined surface surrounding the runway prepared or suitable for reducing risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the runway.

Small Airplane: An airplane of 12,500 pounds or less maximum certificated takeoff weight.

Taxilane: The portion of the aircraft parking area used for access between taxiways and aircraft parking positions.

Taxiway: A defined path established for the taxiing of aircraft from one part of the airport to another.

Terminal Building: A building or buildings designed to accommodate the enplaning and deplaning activities of air carrier passengers.

Terminal Facilities: The airport facilities providing services for air carrier operations that serve as a center for the transfer of passengers and baggage between surface and air transportation.

Transport Airport: An airport designed, constructed, and maintained to serve airplanes in Aircraft Approach Category C and D.

Utility Airport: An airport designed, constructed, and maintained to serve airplanes in Aircraft Approach Category A and B.

VFR Airport: An airport without an authorized or planned instrument approach procedure.

APPENDIX B

Tie-Down Parking Areas

How To Size An Apron Parking Area

The appendix explains how to size an apron parking area and the reasoning behind starting with a Group I tie-down position and what size it should be.

Tie-Down Layout

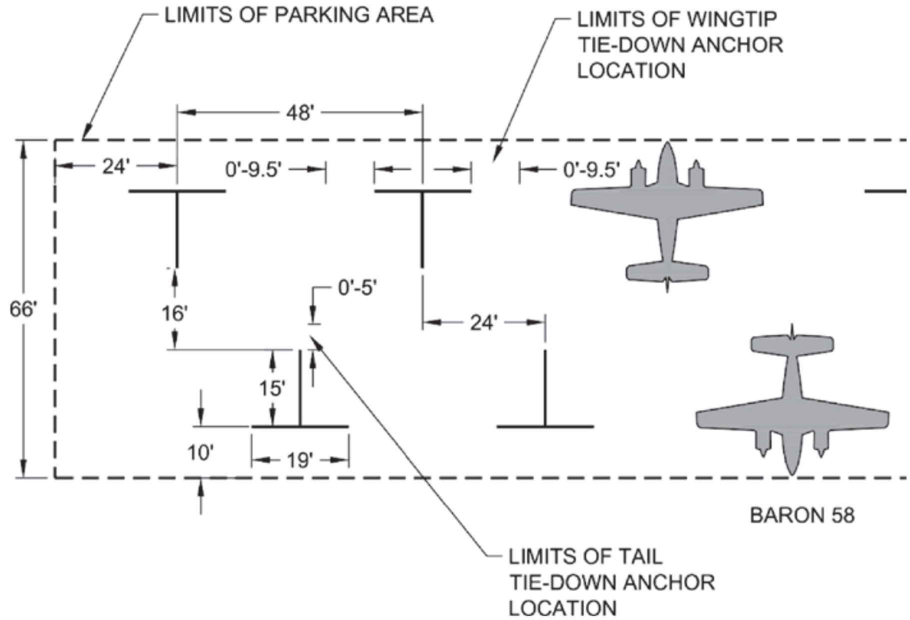
FAA Advisory Circular 150/5300-13A (AC-13A), Appendix 5 provides guidance for laying out tie-down parking positions for GA aircraft. AC-13A suggests that the tie-down size should be based on the largest aircraft that will be tied down. A sampling of tie-down sizes was taken from the airports used in the Data Collection phase of developing this Guidebook. The sizes ranged from 24′ × 17′ to 40′ × 20′. To provide a similar sized tie-down and meet the new AC guidelines, it was decided that an aircraft that provided a similar sized tie-down should be chosen to configure a "base" tie-down layout. Using the guidelines in AC-13A and a Beech Baron 58, a tie-down position of 38′ × 20′ was developed.

Notes:

- For this Guidebook, a Tie-down position and a Parking position are NOT the same. A Tie-down position can only accommodate an aircraft up to the size aircraft it was designed for, while a Parking position is the space or area taken by any size aircraft within the parking area.
- For this Guidebook, the apron PARKING AREA is only the portion of the apron acceptable for aircraft to park and does not include the taxilane or TOFA.

AC-13A indicates that tie-down anchors should be placed at the wingtips and the tail. However, based on the tie-down points on a Beech Baron 58 and similar sized aircraft, the wingtip tie-down anchors are approximately 10 feet away from the tie-down points. This position would require very long ropes and may restrict which aircraft can tie-down due to the different tie-down points on different aircraft. Placing the tie-down anchors for the wings at the ends of the painted "T"s, which are 19 feet apart, will provide greater flexibility for a variety of aircraft and will not require such long ropes. While a location for the anchors is recommended, each airport should consider its situation when locating the anchors. This layout is similar in size to the majority of tie-downs found at the sample airports. Figure B-1 depicts the tie-down dimensions.

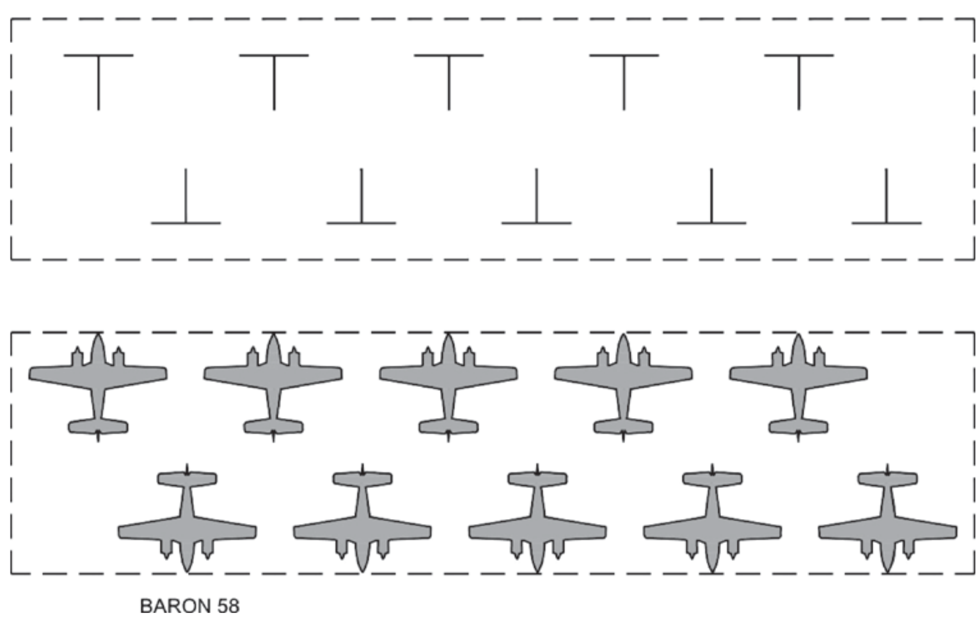
Basing a tie-down position on a larger aircraft will cause the area required to tie-down a similar number of aircraft to grow dramatically with only marginal benefits. For example, the area needed



Source: Delta Airport Consultants, Inc.

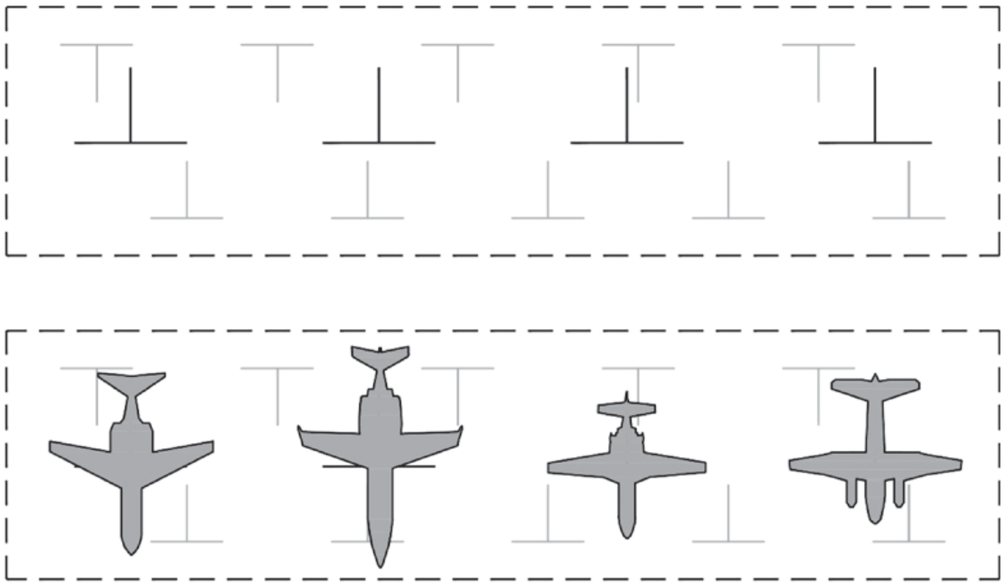
Figure B-1. Tie-down dimensions for Beech Baron 58 aircraft per AC 150/5300-13A.

to tie-down 10 nested Piper PA-31 Navajos would require 24% more pavement than an area required for 10 Baron 58s. The area for 10 Baron 58s can be configured to accommodate up to four larger aircraft which could safely accommodate a Piper PA-31 Navajo along with larger and smaller aircraft. Using the AC, a tie-down layout for 10 Baron 58s was developed and is depicted in Figure B-2. Figure B-3 uses the same parking area but is marked for four larger aircraft. The tie-down anchors can still be installed for the 10 tie-down positions if there is a need.



Source: Delta Airport Consultants, Inc.

Figure B-2. Parking area for 10 Beech Baron 58 tie-down positions.



Note: The lighter lines depict the nested tie-down positions available for small aircraft
Source: Delta Airport Consultants, Inc.

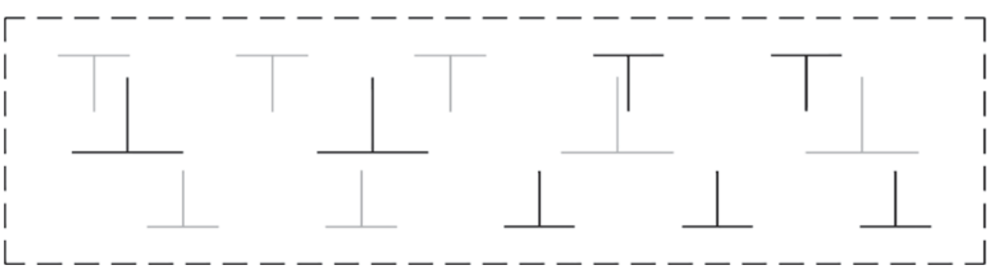
Figure B-3. Parking area for 10 Beech Baron 58 tie-down positions marked for larger aircraft.

As shown in Figures B-3 and B-4, the same parking area can accommodate either 10 small Group I aircraft in a nested configuration or four large Group I or small Group II aircraft in standard configuration. The area can also be marked to accommodate both sized aircraft to meet the needs of the airport.

The tie-down layout is only a recommendation for planning purposes. Space constraints or a different size aircraft may require a different configuration.

Depth of the Parking Area

While Group II aircraft have wingspans less than 79 feet, they have lengths that vary between 50 feet and 90 feet. To right size the apron, the depth of the parking position must be determined. Using the minimum depth of a Group I nested parking area of 66 feet as determined previously, all current Group I aircraft in use can be accommodated without impacting the adjacent TLOFAs. The current longest Group I aircraft in use is the Learjet 60, which at 58 feet will fit within this depth. If your apron is a Group I apron, then you are finished determining the depth.



Note: The lighter lines depict other available parking positions
Source: Delta Airport Consultants, Inc.

Figure B-4. Tie-down positions marked for both small and large aircraft.

If your apron needs to accommodate Group II aircraft, you now need to determine what length of aircraft you will need to accommodate. The 66 foot depth of the nested tie-down parking area can accommodate approximately 54% of the existing Group II aircraft in use.

Sampling of Group II aircraft less than 66 feet long:

- Cessna Citation CJ2
- Cessna Citation XLS
- Dassault Falcon 50
- Gulfstream G150
- Hawker 800
- Beech King Air C90
- Embraer Phenom 300

If you anticipate Group II aircraft longer than 66 feet, a depth of 75 feet would accommodate approximately 83% of the existing Group II aircraft in use.

Sampling of Group II aircraft between 66 and 75 feet long:

- Gulfstream G280
- Cessna Citation X
- Bombardier Challenger 300
- Bombardier Challenger 605
- Hawker 4000
- Dassault Falcon 900

If you anticipate Group II aircraft longer than 75 feet, a depth of 100 feet would accommodate 100% of the existing Group II aircraft in use.

Sampling of Group II aircraft between 75 feet long and 100 feet long:

- Gulfstream G350
- Gulfstream G450
- Embraer Legacy 600

While the proposed apron depths are more than the longest aircraft in each range, the extra distance provides flexibility and a margin of error if the aircraft is not centered in the parking area. In all cases, the Group I tie-down positions are centered within the parking area.

These depths are only a recommendation for planning purposes. Space constraints or a different size aircraft may require a different depth.

Add Taxiway and Taxilane Areas to Access the Parking Area

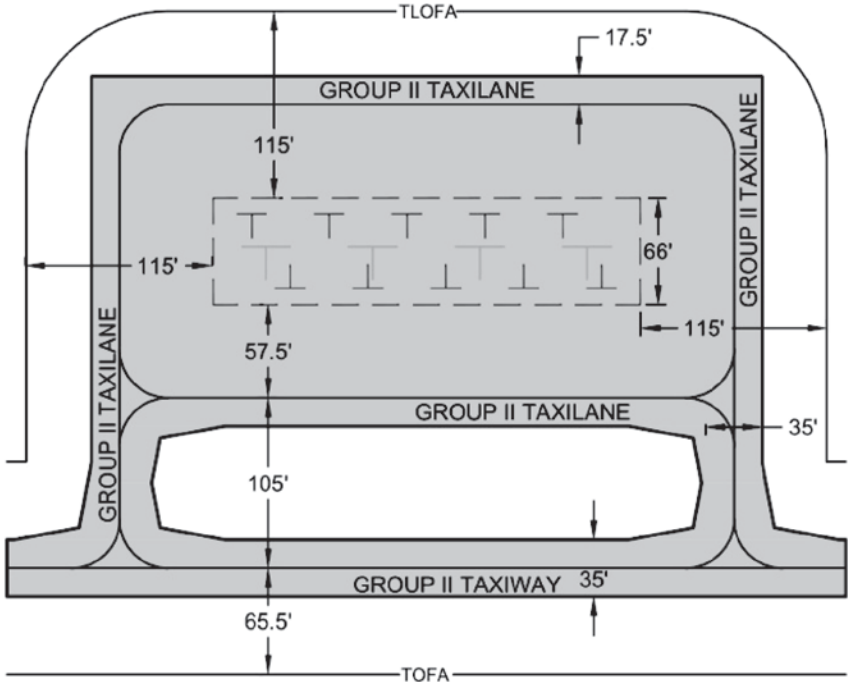
Now that the parking areas have been established, the appropriate TLOFA and taxiway object free areas (TOFA) have to be added to the apron. Chapter 4 of AC-13A will provide the dimensions for the clear areas. It is very important to provide Group II taxilanes for Group II parking positions.

Figures B-5 and B-6 are examples of complete apron layouts with tie-downs, parking areas, taxilanes, and taxiways.

For airports not staffed full time or that do not have a full-time parking attendant with the ability to position aircraft to fit in the available space, parking positions should be provided to allow power-in, power-out operations of the largest aircraft anticipated.

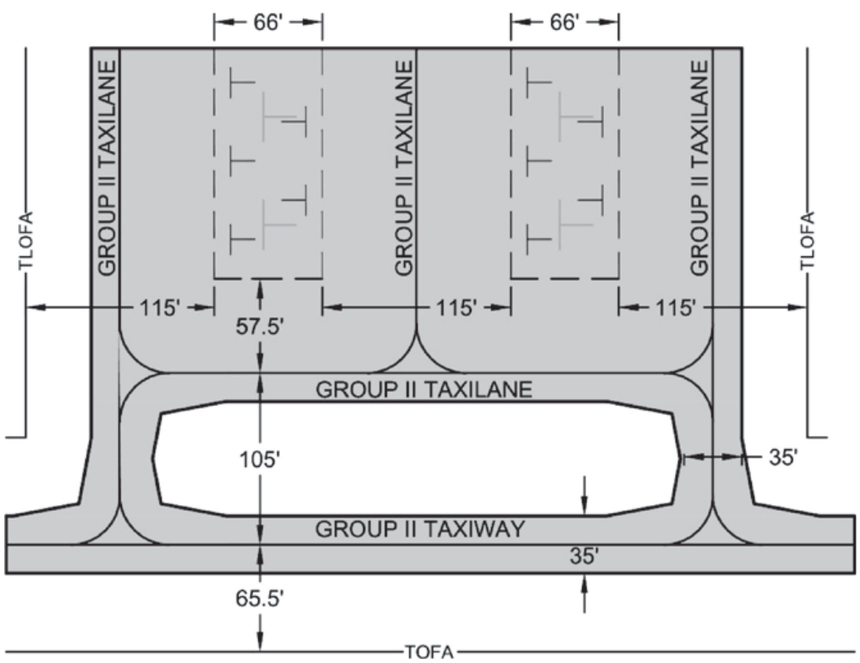
Group III Aprons

The aprons discussed above are for Group I and Group II aircraft. If Group III aircraft are anticipated, similar to a Gulfstream G550 or Bombardier Global Express, the frequency and number of these sized aircraft must be considered prior to deciding on the size of your apron.



Source: Delta Airport Consultants, Inc.

Figure B-5. Sample Group II Apron Layout One.



Source: Delta Airport Consultants, Inc.

Figure B-6. Sample Group II Apron Layout Two.

APPENDIX C

Determining the Number of Aircraft Parking Positions

Determine the Number of Transient Aircraft Parking Positions

If an approved master plan and ALP exists, the number of required parking positions should already be known. If not, the forecasts from the approved master plan can be used to determine the number of transient parking positions. Based aircraft parking positions will be determined later. Below are equations and samples to help determine the number of transient parking positions.

Equation to Determine No. of Transient Parking Positions

Using the operations from the master plan forecast, the number of aircraft parking positions can be calculated using the following equation:

$(X/2 * T)/365 * P =$ Number of Transient Parking Positions

where

X = number of operations
T = percent of operations that are transient (to be determined by Airport Owner/Operator and Consultant based on onsite observations)
P = percent of transient aircraft that are parked on the apron at the same time (to be determined by Airport Owner/Operator and Consultant based on onsite observations)

Using the equation, the number of parking positions is determined. However, not all parking positions are the same size. Unless there is a known aircraft of a certain size that requires special consideration, Table C-1 provides a general rule of thumb to determine an equivalent number of nested tie-down positions.

Determine the Number of Based Aircraft Parking Positions

The parking positions and apron areas described above were planned for the transient aircraft only. Apron space for based aircraft also needs to be determined. Each airport is different in the number of based aircraft stored on the apron. The majority of based aircraft parked on an apron are single-engine piston and small multi-engine piston aircraft. Larger and generally more expensive aircraft are usually parked in a hangar. Additional consideration should also be given to spaces for special uses such as flight training school.

Approximately half the State Airport System plans have planning guidance on how much apron space and hangar space to provide for aircraft storage. Many provide percentages for aircraft to be stored in a hangar versus on an apron. Several give additional guidance on the percentages based on the type or level of airport for that state. For instance, one state indicates that tie-downs

Table C-1. Equivalent tie-down positions.

Aircraft Type (1 parking position)	Equivalent nested tie-down positions (Beech Baron 58)
Single-Engine Piston	1
Multi-Engine Piston/Turboprop	2.5
Jet	3
Rotorcraft	2

Source: Delta Airport Consultants, Inc.

should be provided for 25% of the based aircraft and 75% of the transient aircraft. That same state indicates that 75% of the based aircraft should be stored in hangars and hangars should be available for storage of 25% of the transient aircraft. Most State Airport System plans that have guidance on storage of based aircraft recommend that 75% to 100% should be stored in hangars.

Each airport is different with regards to their needs for based aircraft apron parking. The needs should be based on historical records of based aircraft storage, demand for hangars, available development space, and funding. While funding is available for hangar construction, it is a low priority. An apron is AIP eligible and carries a higher priority. If funds are not available for hangar construction, planning for a greater number of based aircraft being stored on an apron should be considered. A planning guideline for number of based aircraft parking positions should be between 10% and 25% of based aircraft.

Example

Table C-2 provides information from a master plan for a fictional airport that will be used to determine the number of tie-down positions.

For this example, we will determine the near-term needs (10 years) and not the long-term parking needs (20 years)

Number of positions for transient aircraft needed in 10 Years at Sample Airport

Step 1: Determine number of Transient positions

Step 1A: Determine number of parking positions using the formula from Page 1.

SEP: [(12,000/2 * 30%) / 365 * 40%] = 1.97 (use 2)

MEP/TP: [(6,000/2 * 30%) / 365 * 40%] = 0.98 (use 1)

Jet: [(3,500/2 * 30%) / 365 * 40%] = 0.57 (use 1)

Rotorcraft: [(300/2 * 30%) / 365 * 40%] = 0.05 (use 0)

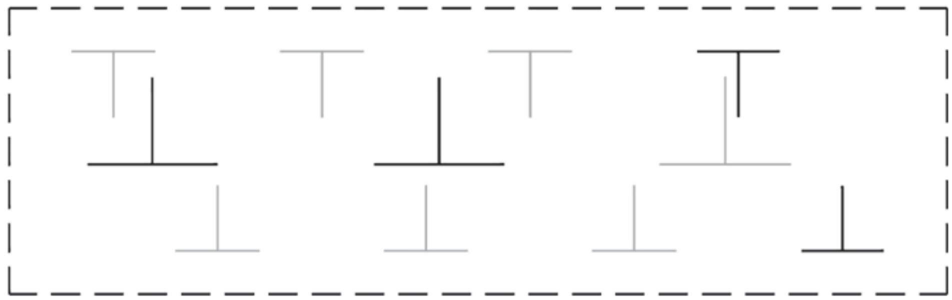
Other: [(75/2 * 30%) / 365 * 40%] = 0.01 (use 0)

Total: 4 positions

Table C-2. Operations and based aircraft forecast Sample Airport.

	Today		10 Years		20 Years	
	Ops	Based Aircraft	Ops	Based Aircraft	Ops	Based Aircraft
Single-Engine Piston (SEP)	10,000	18	12,000	22	15,000	26
Multi-Engine Piston/Turboprop (MEP/TP)	5,000	3	6,000	4	8,000	6
Jet	1,500	0	3,500	1	4,500	2
Rotorcraft	200	0	300	0	400	1
Other (ultralight/glider)	50	0	75	0	100	0
Total:	16,750	21	21,875	27	28,000	35

Source: Delta Airport Consultants, Inc.



Note: The lighter lines depict other available parking positions
Source: Delta Airport Consultants, Inc.

Figure C-1. Transient tie-down positions marked for Sample Airport.

Step 1B: Determine the equivalent number of nested tie-down positions using Table C-1.

SEP:	2 = 2
MEP/TP:	1 = 2.5
Jet:	1 = 3
Total:	**7.5 (use 8)**

Figure C-1 depicts a possible layout that would satisfy the forecast demand for transient aircraft at Sample Airport.

The apron has four parking positions marked, two for small single-engine piston aircraft, one for multi-engine turboprop, and one for jet aircraft. This parking area and tie-down configuration allows the flexibility of having eight small aircraft, three larger aircraft, or a combination of both.

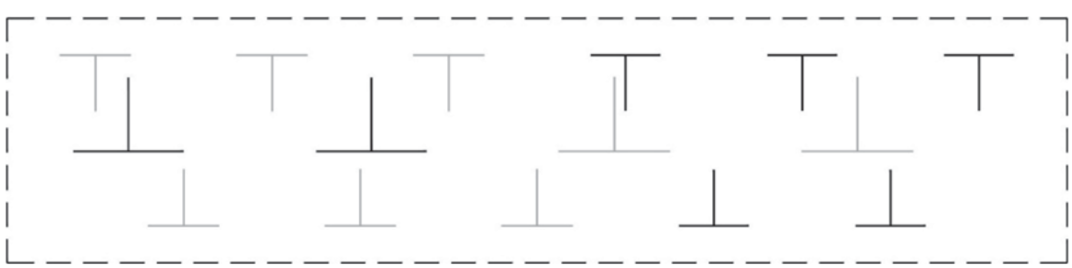
Step 2: Determine Number of Based positions

Using the percentage guideline mentioned above and the based aircraft count in Table C-2, the 27 based aircraft forecast for 10 years with 10% based on the apron, would amount to 2.7 tie-down apron positions, which would be rounded to three tie-down positions.

Step 3: Total Parking Positions and Parking Area Layout

Adding the three based aircraft tie-down positions to the 8 transient tie-down positions would result in a parking area that would need to accommodate 11 tie-down positions. Figure C-2 depicts a possible layout that would satisfy the forecast demand for transient and based aircraft at Sample Airport.

See Chapter 5 and Appendix B to size the total apron and parking area.



Note: The lighter lines depict other available parking positions
Source: Delta Airport Consultants, Inc.

Figure C-2. Total tie-down positions marked for Sample Airport.

APPENDIX D

Bibliography of Planning Resources

Key FAA ACs, Orders, and Other Publications

AC 150/5070-6B, *Airport Master Plans*
This advisory circular provides guidance to airports of all sizes on the developing an airport master plan. This document outlines the required process and elements of an airport master plan. The master plan is the basis for nearly all improvements to GA facilities and this circular ensures that all airports follow the appropriate steps to plan for its future development.

AC 150/5220-18A, *Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials*
This advisory circular provides guidance for the site selection and design of buildings used to store and maintain airport snow and ice control equipment, store approved materials, and provide personnel areas required to support the requirements under the airport operator's winter storm management plan.

AC 150/5230-4A, *Aircraft Fuel Storage, Handling, and Dispensing on Airports*
This advisory circular identifies standards and procedures for storage, handling, and dispensing of aviation fuel on airports. The circular directs airports to the National Fire Prevention Association (NFPA) 407, Standard for Aircraft Fuel Servicing when designing fuel storage facilities.

AC 150/5300-13A, *Airport Design*
This advisory circular provides standards and recommendations for airport design. This document describes the standards on the appropriate distances and sizes of the various airport safety areas and the appropriate facilities that can be within or near each of the various safety areas.

AC 150/5320-5C, *Surface Drainage Design*
This advisory circular provides guidance for engineers, airport managers, and the public in the design and maintenance of airport surface drainage systems. When developing GA facilities, it is important to reference this circular for effective drainage development to mitigate possible impacts to water quality.

AC 150/5360-9, *Planning and Design of Airport Terminal Facilities at Non-Hub Locations*
This advisory circular provides general reference material for the planning and design of airport terminal buildings at non-hub locations. It provides planners with the most important items to consider when developing and designing a new terminal. The circular notes the factors that should be considered when determining a location of a new terminal such as FAA design standards, the type of aircraft using the airport (currently and in future), relationship to other airport facilities, physical siting restrictions, and access to roads. The circular provides facility requirement graphs to ensure that appropriate facilities are included in the terminal development such as aircraft parking, auto parking, terminal curb, public areas, airline space

(if applicable), concessions, utility systems, offices, federal inspection facilities, and other special considerations.

AC 150/5390-2C, *Heliport Design*
This advisory circular provides standards for the design of heliports serving helicopters with single rotors. If an airport accommodates helicopter activity or plans to in the future, it will be important to consider this advisory circular to ensure appropriate adherence to heliport safety areas, the developing helicopter parking, and terminal and auto parking facilities to accommodate helicopter passengers.

Order 5050.4B, *National Environmental Policy Act Implementing Instructions for Airport Projects*
This order provides guidance and requirements for assessing the environmental impacts of airport development.

Order 5100.38C, *Airport Improvement Program Handbook*
This order provides guidance and requirements for funding of airport grant projects.

Order 5190.6B, *FAA Airport Compliance Manual*
This order provides guidance and requirements for federal obligations.

FAA Report, *General Aviation Airports, A National Asset*
This report documents FAA's study of nearly 3,000 GA airports and highlights the role they play. It aligns them into four categories—national, regional, local, and basic—based on their activity levels.

Guidance on General Aviation Airport Terminals, FAA Bismarck Airports District Office, 2005
The FAA Bismarck ADO provides guidelines on basic GA terminal design which include items such as restrooms, a heating, ventilation, and air conditioning (HVAC) room, common room, etc.

Title 14 Code of Federal Regulations, Part 77, *Safe, Efficient Use, and Preservation of the Navigable Airspace.* This regulation establishes standards for identifying obstructions to aircraft in navigable airspace.

Title 14 Code of Federal Regulations, Part 139, *Airport Certification.* This regulation specifies certification and operational requirements for airports serving air carrier aircraft.

Title 14 Code of Federal Regulations, Part 150, *Airport Noise Compatibility Planning.* This regulation implements the noise compatibility standards and provisions contained in the Aviation Safety and Noise Abatement Act of 1979.

Trade Group Publications

AOPA

- *Airport Advocates: Participating in the Planning Process*
- *Aircraft Hangar Development*
- *Minimum Standards for Commercial Aeronautical Activities*
- *Guide to Airport Noise and Compatible Land Use*
- *Media Tools: What is General Aviation*

National Air Transportation Association (NATA)

- *How Many FBOs Are Enough?—Guidelines for Evaluating Airport Competition*
- *The Importance of a Long-Term Lease in Aviation Agreements*
- *Leaving Aeronautical Services to Aeronautical Business*
- *The Importance of Minimum Standards and Rules and Regulations for a Successful Airport—FBO Relationship*

General Aviation Airport Coalition (GAAC)

- AIP cost-share summary by state
- Operations-related sample documents such as airport use ordinance, an airport master plan (Minden-Tahoe), rules and regulations, minimum standards, mobile fueling program, t-hangar operating regulations and insurance requirements, ground lease agreement, a hangar lease
- Selected state airport economic impact studies (DE, FL, IA, MA, ND, NY, OR, PA, TX, VA, WA)

ACRP Publications

ACRP Legal Research Digest 9: Case Studies on Community Challenges to Airport Development
This digest explores judicial decisions related to challenges to airport expansion and development.

ACRP Legal Research Digest 11: Survey of Minimum Standards: Commercial Aeronautical Activities at Airports
This legal research digest provides sources for adopting and enforcing minimum standards for commercial aeronautical activities at an airport such as aircraft fueling, ground handling services, aircraft maintenance and repair, storage, aircraft rental, flight training, sales, and charters.

ACRP Synthesis 3: General Aviation Safety and Security Practices
This report discusses approaches and techniques on how to secure facilities at GA airports such as fueling facilities and access points, and perimeter fencing, as well as provides discussion on wildlife control methods.

ACRP Synthesis 21: Airport Energy Efficiency and Cost Reduction
Synthesis report describes planning initiatives and practices that have been taken for energy conservation management at airports. Specifically, the report provides information on energy efficient projects, controls, operations, and practices for improving the efficiency of elements such as HVAC, lighting, and insulation.

ACRP Synthesis 25: Strategies for Reuse of Underutilized or Vacant Airport Facilities
Synthesis provides strategies, approaches, and methodologies for utilizing vacant and underused airport facilities such as hangars, terminals, FBOs, and other aeronautical support infrastructure. Though the report provides several examples of structure reuse at airports with commercial airline service, lessons learned can be applied to facilities at GA airports.

ACRP Report 1: Airports and the Newest Generation of General Aviation Aircraft—Volume 2: Guidebook
This Guidebook provides information on facility requirements for newer generation GA aircraft such as requirements for runway length, runway width, pavement strength, taxiway/taxistreet dimensions, hangar design, and ground handling services. Other information is provided on other facility requirements such as ground access and support facility requirements.

ACRP Report 10: Innovations for Airport Terminal Facilities
Much of the information in this report pertains to commercial service airports; however, concepts can be applied to facilities at GA airports. In particular, Chapter 5 offers considerations and concepts for landside facilities such as roadways and parking lots.

ACRP Report 14: Deicing Planning Guidelines and Practices for Stormwater Management Systems
This report explores a wide array of practices designed to provide for the practical, cost-effective control of runoff from aircraft and airfield deicing and anti-icing operations.

ACRP Report 16: Guidebook for Managing Small Airports
Chapter 4 of this document provides information on airport planning and development that includes development and construction standards for plans, specifications, construction activities, and environmental considerations.

ACRP Report 20: Strategic Planning in the Airport Industry
A comprehensive discussion of strategic airport planning practices is presented in this report; it may not be applicable to all GA airports.

ACRP Report 27: Enhancing Airport Land Use Compatibility—Volume 1: Land Use Fundamentals and Implementation Resources
Volume 1 of this report discusses concerns, roles, responsibilities, and regulatory guidance for land use compatibility around airports. Information presented in the report is designed to help protect airports from incompatible land uses that can impair current and future airport operations and development. This report could be used as a part of infrastructure planning at an airport.

ACRP Report 32: Guidebook for Addressing Aircraft/Wildlife Hazards at General Aviation Airports
This report offers a comprehensive look at the wildlife control challenges that face general aviation airports and highlights appropriate strategies and techniques that can be applied to GA airport wildlife control programs. Information from this report could be applied in designing facilities that help to deter wildlife.

ACRP Report 38: Understanding Airspace, Objects, and Their Effects on Airports
A comprehensive description of the regulations, standards, evaluation criteria, and processes for airspace protection around airports is presented in this report. This report is beneficial in describing airspace protection issues to those who may not have a strong technical understanding of the associated issues which can assist in infrastructure planning decisions.

ACRP Report 43: Guidebook of Practices for Improving Environmental Performance at Small Airports
This report outlines federal environmental regulations and requirements for small airports to improve their environmental stewardship. Quick reference summary graphics provide information on how to implement a particular activity. Case studies of environmental initiatives already undertaken are provided to serve as a guide for other airports. Document could be used to assist in the design of environmentally friendly infrastructure elements.

ACRP Report 47: Guidebook for Developing and Leasing Airport Property
Issues associated with developing and leasing airport land for aeronautical and non-aeronautical use is summarized in this report with best practices presented from the perspective of the airport sponsor. In addition, templates are available to present aeronautical and non-aeronautical uses of airport property to non-technical audiences that provide content, examples, and definitions for presentations to community stakeholders.

ACRP Report 49: Collaborative Airport Capital Planning Handbook
Guidance is provided in this report to those who are responsible for, or have a stake in, developing, financing, managing, and overseeing an airport capital improvement plan the individual projects included in it.

ACRP Report 53: A Handbook for Addressing Water Resource Issues Affecting Airport Development Planning
Section 2 outlines how to establish a water resource issue management program while Section 3 offers strategies for integrating water resource issue management with the project implementation process.

ACRP Report 68: Guidebook for Evaluating Terminal Renewal versus Replacement Options
Details a step-by-step process for conducting a business-driven evaluation of competing options to renew or replace airport terminal facilities.

Other Documents

Airport Planning and Development Handbook. This book by Paul Steven Dempsey provides information about:

- Facilities design (list of necessary infrastructure)
- Runways, taxiways, and aprons general discussion (tailored toward commercial service airports, and no specific dimensions)
- Access by disabled passengers

Airport Engineering. This book by Norman Ashford and Paul H. Wright provides information about:

- Airport lighting, runway and taxiway marking, taxiway guidance signing
- Ground servicing equipment summary (dimensions of typical ground equipment such as fuel trucks, etc.)
- Siting of airport rescue and firefighting facilities and ARFF building design, size of ARFF maneuvering area
- Apron layout, apron facilities and requirements (including fueling facilities)
- Airport drainage (including subsurface drainage)
- Jointing of concrete pavements
- Layout and design of heliports

Planning and Design of Airports. This book by Robert Horonjeff and Francis X. McKelvey includes information as follows:

- Chapter 7—Airport Configuration
- Chapter 9—Geometric Design of the Landing Area (runways, taxiways, separation requirements) Note that some of this data is outdated, and based on previous versions of the airport design AC
- Chapter 10—Planning and Design of the Terminal Area (note that the majority of this content is related to commercial service passenger terminals, not GA terminals)
- Chapter 13—Lighting, Marking, and Signing
- Chapter 14—Airport Drainage

Airport Planning & Management. This book by Alexander T. Wells, Ed.D., provides information about:

- Chapter 5—Airport Layout and Land Use Plans (shows some general facility layouts)
- Chapter 13—Airport Operations (discusses the use of several vehicles/equipment that may need to operate on taxiways, runways, aprons)

National Fire Prevention Association (NFPA) 407, *Standard for Aircraft Fuel Servicing*, 2012 Edition
The NFPA's Standard for Aircraft Fuel Servicing describes the standards for design and operations for aircraft fueling. Design standards for hose requirements, fuel systems, self-service fueling stations, and fueling vehicles and carts are provided. GA airports should use this document when developing and maintaining fuel systems and/or stations.

National Fire Prevention Association (NFPA) 409, *Standard of Aircraft Hangars*, 2011
This standard contains the minimum requirements for the proper construction of aircraft hangars and protection of aircraft hangars from fire.

National Fire Prevention Association (NFPA) 415, *Standard on Airport Terminal Buildings, Fueling Ramp, and Loading Walkways*, 2013 Edition
This standard specifies the minimum fire protection requirements for the construction and protection of airport terminal buildings. It specifies the minimum requirements for the design and

maintenance of the drainage system of an aircraft fueling ramp to control the flow of fuel that can be spilled on a ramp and to minimize the resulting possible danger. In addition, it contains the minimum requirements for the design, construction, and fire protection of aircraft loading walkways between the terminal building and aircraft.

TSA Security Guidelines for General Aviation Airports, Information Publication A-001, May 2004
This document provides owners, operators, sponsors, and other stakeholders with a vested interest in airports with a way to determine when and where security enhancements may be appropriate. The document provides an extensive list of options and suggestions for airports to consider when determining which security enhancements to implement.

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
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
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
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