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of Transportation
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Administration

Advisory Circular

Subject: Airport Terminal Planning and Design

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1 Purpose.

This advisory circular (AC) provides updated guidance on the process of planning and designing airport terminal facilities. This update reflects the many changes that have occurred in the aviation industry and to planning and design practices for airport terminal facilities since the previous versions of the ACs were drafted.

2 Distribution.

This AC is located on the Federal Aviation Administration (FAA) Office of Airports website where it is available to all interested parties.

3 Cancellation.

This AC cancels the following two ACs:

- AC 150/5360-13, Planning and Design Guidelines for Airport Terminal Facilities, dated April 22, 1988; and
- AC 150/5360-9, Planning and Design Guidelines for Airport Terminal Facilities at Non-hub locations, dated April 4, 1980

4 Application.

This AC provides guidance as a reference document and starting point for anyone initiating the planning and design of airport terminal facilities, typically post-master plan or during the master planning process. The focus of the AC is on the process of airport terminal facility planning and design and key considerations that should be made during the process. For more detailed information, references are made to relevant ACs, orders, Transportation Research Board (TRB) reports and industry guidance. For information on Airport Improvement Program (AIP) or Passenger Facility Charge (PFC) eligibility and justification, refer to Section 1.3 in this AC, FAA Order 5100.38, *Airport Improvement Program Handbook* and the *Passenger Facility Charge Handbook*, FAA Order 5500.1.

5 **Principal Changes.**

This AC:

1. Combines ACs: 150/5360-13, *Planning and Design Guidelines for Airport Terminal Facilities* and AC 150/5360-9, *Planning and Design Guidelines for Airport Terminal Facilities at Non-hub locations.*
2. Provides initial planning considerations that should be made before and during the terminal planning and design process.
3. Presents the framework of a basic terminal planning and design process and key considerations for each step.
4. Incorporates a chapter on the fundamentals of sustainability in terminal planning and design.
5. Provides references to relevant ACs, Orders, TRB reports and industry guidance on terminal planning and design.
6. Refrains from providing quantitative guidance for sizing terminal components that is already provided elsewhere in federal, TRB, and industry guidance. Terminal sizing is evaluated on a case-by-case basis.
    a. Note: The previous version of this AC provided a more quantitative approach to guide end users (e.g. using simplified ratios between passenger enplanements and terminal component sizing). Substantial review and study was conducted to assess the previous guidance and to define the scope of this AC. Given the unique nature of each airport environment and site specific considerations, the approach of the previous AC was found to be inflexible for the site specific nature of planning and designing terminal facilities.

6 **Feedback on this AC.**

If you have suggestions for improving this AC, you may use the Advisory Circular Feedback form at the end of the document.

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CHAPTER 1. USE OF THE ADVISORY CIRCULAR

1.1 Intended Audience

This document is written to provide guidance as a reference document and starting point for anyone initiating the planning and design of an airport terminal facility, including (but not limited to) the following:

- Airport operators.
- Airport leadership.
- Airport planning staff.
- Airport engineering staff.
- Public stakeholders.
- FAA field personnel.
- Consultants.
- Airport planners.
- Terminal planners.
- Architects.

1.2 Organization and Use of this Advisory Circular

The 11 chapters in this AC are presented in three main parts:

1. Initial Planning Considerations (Chapter 2) – Identifies key considerations that should be made prior to any terminal planning or design project.
2. Terminal Planning and Design Process (Chapter 3) – Discusses an approach to the planning and design process with emphasis on flexibility.
3. Terminal Planning and Design Methodologies and Tools (Chapters 4 through 11)
    - Covers the three main functional elements in the terminal area (terminal building, terminal apron, terminal landside); provides considerations that should be made for each element and applicable reference documents and tools for each.
    - Discusses the topic of sustainability in terminal planning and design.
    - Discusses non-hub terminal facilities and other considerations that should be made.

Using the framework process presented in the following chapters, the user is provided a basic explanation for each key subject and functional area and then referred to more in depth resources.

It should be noted that this guidance combines AC 150/5360-13, *Planning and Design Guidelines for Airport Terminal Facilities* and AC 150/5360-9, *Planning and Design Guidelines for Airport Terminal Facilities at Non-hub locations*. The processes for hub and non-hub terminal facilities planning and design were found to be the same and not warranting two separate discussions. However, given the relative differences in scale between hub and non-hub facilities, it was determined that some key considerations should be highlighted for non-hub facilities. Please refer to Chapter 10 for additional considerations on non-hub airport terminal facilities.

1.3 Use of this Advisory Circular and Financial Considerations

This AC presents a wide range of information on the topic of planning and designing terminal facilities. The discussion presented here is independent from guidance on Airport Improvement Program (AIP) or Passenger Facility Charge (PFC) eligibility and justification. This AC and the use of this AC does not establish or ensure project eligibility or justification for AIP or PFC funding. For information on AIP or PFC eligibility and justification, refer to FAA Order 5100.38, *Airport Improvement Program Handbook* and the *Passenger Facility Charge Handbook*, FAA Order 5500.1.

Specific information on the allocation of public-use space and non-public use space are not part of this AC, but are covered in detail in FAA Order 5100.38, *Airport Improvement Program Handbook.* For airports in the National Plan of Integrated Airport Systems (NPIAS), airport operators should coordinate with FAA Office of Airports Regional or Airports District Office staff to discuss the project.

1.4 Use of Other Industry Publications

The focus of this AC is on the process of planning and designing airport terminal facilities. As such, there are many publications that appropriately focus, in significantly more depth, on the detailed quantitative elements of terminal planning and design for each respective discipline encountered within the terminal area. To avoid duplicative guidance and recognize the natural evolution of terminal planning factors and practices, this AC provides references to other relevant resources. References are provided within the text in the following sections, and are also summarized in **Appendix B**, Reference Materials.

CHAPTER 2. INITIAL PLANNING CONSIDERATIONS

2.1 General

This chapter presents and discusses key considerations that need to be made before and during the formal terminal planning and design process. Particular emphasis should be placed on this early stage of the process as the outcome will form the scope of work for the project.

2.2 Situation Assessment and Strategic Planning

Before initiating a terminal planning and design process, airport operators should conduct a situation assessment to identify the problems and decide what the process is specifically intended to address. A situation assessment can include asking the following questions:

- What problem(s) needs to be solved in regards to the existing terminal facility?
- Has the existing terminal infrastructure (or components thereof) reached the end of its useful life?
- Does the overall terminal complex (or any of its individual components) no longer meet current or evolving operational needs and require renovation, expansion, or replacement?
- Is the overall terminal complex (or any of its individual components) simply too small, or too large, to accommodate current or projected demand?
- Are there changes or expected changes in the operational fleet or to airline tenants?
- Does the terminal need overall modernization or aesthetic improvements to meet changing user and community expectations?
- What specific passenger or tenant complaints about the facility need to be addressed?
- Are there multiple problems representing a combination of the above?
- Has the terminal facility (or any of its individual components) suffered significant damage or closed due to storms, electrical outages, flooding or other external factors?
- Have previous planning studies (e.g. an Airport Master Plan or related planning study) explored the questions above or identified terminal related projects?
- Are any environmental impacts anticipated as part of the project? It is critical early in the process to anticipate and include the appropriate level of NEPA review and coordination.

Documentation and communication of the outcomes of the situation assessment are important parts of the process. Documentation of the exact problems that need to be resolved is necessary to define the goals and objectives and ensure there is consensus among stakeholders and others who will play an integral role in the planning and design process.

2.3 Establishing Goals and Objectives

Once the situation assessment is completed, it is important at the outset of the terminal planning process to have a clear understanding of the goals and objectives so that the effort is addressing the appropriate problems and issues. The goals and objectives should define the purpose and motivation behind the need for the new, expanded, or renovated terminal facility. Goals and objectives should be prioritized and align with: (a) the airport operator's overall vision and mission for the terminal facility and airport enterprise, (b) the airport operator's funding capabilities, and (c) the motivations and needs of primary stakeholders such as governmental leadership, airline tenant(s) and users of the facility.

It is the responsibility of the planners and designers to clearly articulate this vision in a written set of goals and objectives. Goals and objectives also provide an early coordination opportunity for stakeholders and others to agree that the project is needed in the first place, as well as providing a benchmark against which the options developed for the project may be tested or evaluated. Evaluation criteria for the project should relate to, or draw from, the established goals and objectives.

2.4 Airport Master Plans

Airport master plans are studies prepared to document and support the long-term development and use of an airport's land and facilities. The goal of a master plan is to provide the framework needed to guide future airport development that will cost-effectively satisfy aviation demand and provide a balance of capacity among airport functions, while considering potential safety, environmental and socioeconomic impacts. AC 150/5070-6, *Airport Master Plans*, provides comprehensive guidance on this topic.

In general, an airport master plan should establish the overall context within which detailed terminal planning will occur. In most cases, the terminal planning process should align with the broader framework and guidelines established in the airport master plan.

Airport master plans normally contain basic information useful to the terminal planning process, such as: an inventory of relevant data pertaining to the service area and existing airport facilities, aviation activity forecasts, capacity analyses, estimates of facility requirements, environmental considerations, and various plans on the airport layout, land use, terminal area, and intermodal surface access.

The terminal facility analysis contained in an airport master plan is normally limited to layouts and drawings delineating general location, overall area, and basic configuration of the terminal area development envelope. However, some airport operators develop master plans with a strong emphasis on terminal planning and may provide documentation to a more detailed level.

2.5 Other Factors for Initial Consideration

The following summarizes additional factors associated with a successful airport terminal planning process.

2.5.1 Project Team

It is important in the initial phase of the process that a project team is assembled that will interact for the duration of the planning process. This team typically identifies the lead person for the planning effort for both the airport and the planning consultant team, along with their key team members. The airport may or may not include stakeholders outside of airport staff for the project team, however involving stakeholders early in the process is always encouraged. Key stakeholders can include: airlines, airport tenants, the consultant team, the FAA (Air Traffic and the Office of Airports), other federal agencies such as the Transportation Security Administration (TSA), Department of Homeland Security (DHS), Customs and Border Protection (CBP), other regulatory stakeholders, local government, local business groups, and community planning groups.

2.5.2 Consultant Selection

Airport operators typically hire a consultant to assist in passenger terminal planning studies. As a general rule, consultant support is procured to provide subject matter expertise and additional labor resources to complete tasks within a given schedule. For information on the selection and engagement of architectural, engineering, and planning consultants see AC 150/5100-14, *Architectural, Engineering and Planning Consultant Services for Airport Grant Projects*. Another useful reference is *Guidelines to Selecting Airport Consultants* published by the Airport Consultants Council, an aviation industry trade association.

2.5.3 Financial Considerations

A number of financial considerations must be addressed early in the process. For example, it is important that airport operators have a realistic sense of their funding capacity as this is a key driver in determining what is ultimately affordable or feasible. A review of airport finances to determine cash on hand, ability to incur debt, revenue streams and potential for grant participation (at the federal, state or other levels) should be conducted early in the process. It is also valuable for the airport operator and key stakeholders to recognize the costs of operating a new or expanded facility and include such information in overall financial feasibility calculations. Additionally, the cost of the terminal improvements to major tenants, such as airlines who may also be financially responsible, should be calculated and given careful consideration.

This AC and the use of this AC does not establish or ensure project eligibility or justification for AIP or PFC funding. For information on AIP project eligibility and justification, please refer to the *Airport Improvement Program Handbook*, FAA Order 5100.38. For information on the PFC program, please refer to the *Passenger Facility Charge Handbook*, FAA Order 5500.1.

2.6 **Terminal Planning Study Design**

A key output of the initial considerations that are described in this chapter is a scope of work that articulates the types of analyses and level of effort needed to address the key issues. For airports in the NPIAS, airport operators should coordinate with their local FAA Office of Airports contacts (in Regional or Airports District Offices) to discuss the project, timeframe, basis for the project, key assumptions (e.g. the forecast of aviation activity used to define facility requirements), level of effort, preliminary NEPA considerations and ultimately to tailor the scope of the effort. The airport operator should develop a scope of work that is appropriate for the circumstances and addresses the identified goals and objectives.

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CHAPTER 3. TERMINAL PLANNING AND DESIGN PROCESS

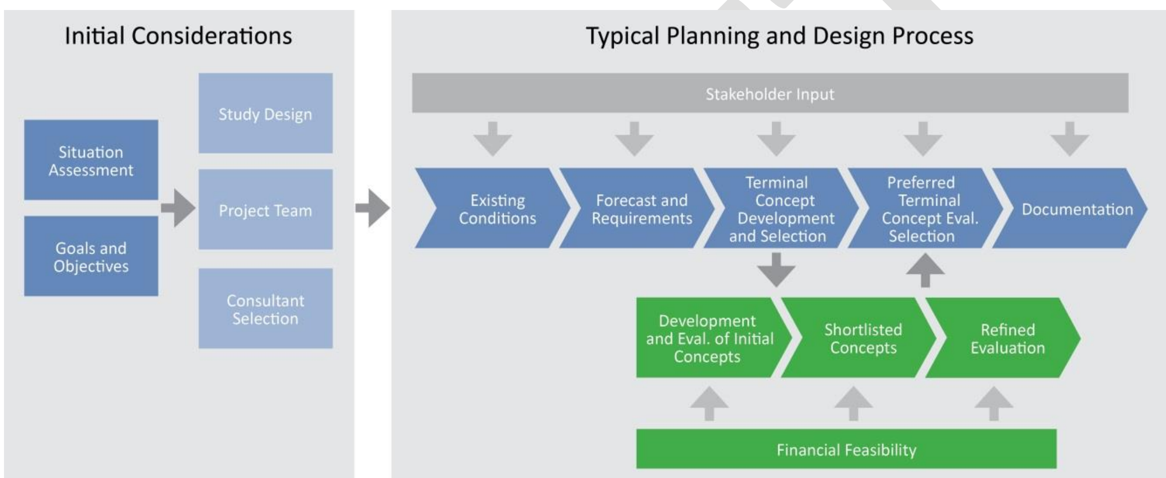
3.1 General

Following the completion of steps identified in Chapter 2 and the development of a scope of work, this chapter describes an approach to a typical planning process with emphasis on flexibility and adaptation.

3.2 Typical Terminal Planning and Design Process

A typical terminal planning and design process is depicted in **Figure 3-1**. Each of the steps identified in the process diagram are described in the following sections with information on each step as well as key considerations that should be made.

Figure 3-1 Conceptual Terminal Planning and Design Process



3.2.1 Initial Planning Considerations

As discussed in Chapter 2 and depicted in **Figure 3-1**, a number of factors should be considered by an airport operator prior to formally initiating the terminal planning process. These steps include assessing the situation and identifying problems to be resolved, establishing goals and objectives, forming the right project team and developing the study scope of work.

3.2.2 Stakeholder Involvement

The process of planning an airport terminal facility requires considerable coordination and input from a number of airport users and other interested parties. Participants in such a process may include, but are not limited to the following:

- Airport management and airport staff from key departments (landside/airside operations, finance, commercial development, airport fire department/local fire department/ airport emergency response staff, airport police, etc.) as well as other airport departments, which can provide valuable perspective and project support.

- Tenant airlines, concessionaires, and other service providers and tenants.
- The terminal planning consultant and other consultants indirectly involved or working on other aspects of the facility.
- The FAA and other federal agencies such as the TSA, DHS, and CBP.
- Relevant local governmental agencies, municipal planning, transportation departments, local business groups, community planning groups etc.
- Other airport users.

Stakeholder involvement runs parallel to the entirety of the process presented in this chapter. Stakeholders or the project advisory committee should be engaged to review terminal planning and design information and provide input at key project milestones. Additionally, it is important to engage the general public as part of the planning process. Public input and information dissemination can take place via workshops, public meetings, project websites, and other methods. For specific information on public participation, see AC 150/5050-4, *Citizen Participation in Airport Planning*.

3.2.3 Existing Conditions

A foundational step in the planning process is the documentation of existing conditions. Documentation of existing conditions refers to the physical characteristics of the facility, as well as the non-physical elements including operational activity, political, demographic, and airport financial conditions.

A base set of plans, documents and photo documentation of existing conditions should be assembled, depicting the appropriate level of information required to support planning efforts and to document key issues identified in the situation assessment. Consideration of the physical characteristics of the existing facility should include a walk-through of the facility, review of the Airport Layout Plan (ALP), the most recent airport master plan, airport layout plan update, other relevant and/or related planning studies, and all existing conditions documents the airport has on file specific to terminal facilities and the surrounding areas (such as electronic drawings of terminal plans, site surveys, utility drawings, and property maps). Additionally, any relevant operational data on functional elements in the terminal complex should be gathered to document demand levels, processing rates, and any other applicable data. A wide range of data (passenger enplanements, aircraft operations, etc.) are available from the FAA Operations Network (OPSNET) website. Data are also available from the FAA Terminal Area Forecast website in a variety of formats. For the purposes of documenting existing conditions, historical data are summarized by year for each facility. The TAF databases may be downloaded in zipped .dbf format through the Download Data link.

Deficiencies in information should be documented by the consultant, and consensus established with the airport operator on how to address them (e.g., will additional work be necessary to obtain basic data, or can assumptions be made on which the planning effort will be based). Throughout the planning process all assumptions used should be clearly documented, including their underlying rationale.

3.2.4 Forecasts and Facility Requirements

Forecast activity levels and related facility requirements are key inputs for the planning process. Aviation activity forecasts are estimations of demand – expressed in passenger activity levels (enplanements and total passengers), aircraft operations, or other factors – expected to be generated for a specified planning period in the future. These two elements are typically conducted during the master planning process or as part of a more focused terminal planning study. Future projections of demand are used to determine the extent and type of development needed to accommodate the expected traffic (e.g., facility requirements). Forecasts provide the basis for estimating the type, level, and approximate timing for airport capital investments and for assessing the environmental and fiscal consequences associated with the required improvements and levels of activity.

In reality, actual passenger and operations activity never follows a straight path, and usually demonstrate “ups and downs.” For this reason, facility requirements and other planning recommendations should be linked to activity milestones (or triggers) defined in terms of planning activity levels, rather than actual future years, which establishes the level of activity that warrants the improvement. This linking enables capital improvements to be delayed or accelerated as actual activity dictates. In addition, base, low, and high growth scenarios can be prepared to “bracket” the potential facility requirements and the resultant terminal development plans. It is critical that the planning process be viewed as dynamic and that potential changes in the aviation industry such as aircraft fleet mix, technology, airport and airline business models, and passenger demographics be considered in the development of forecasts. Flexibility to adapt to changing aviation industry conditions and the economy is one of the most important considerations in terminal planning efforts.

Facility requirements are primarily based on the forecast demand and provide the programmatic input (or sizes) for all of the functional components of the terminal facility. Functional areas are described in detail in Chapter 5, *Functional Relationships and Terminal Concepts.* Requirements and the sizing of the various functional components, and the methods for determining them, are addressed in Chapter 6, *Terminal Building Space Programming*.

Forecasts should conform to FAA requirements per AC 150/5070-6, *Airport Master Plans*.

Finally, at the conclusion of the Forecast and Facility Requirements step, it is critical to establish consensus regarding the outcome and the resulting recommendations with the Project Team and advisory committee before proceeding with the development of concepts.

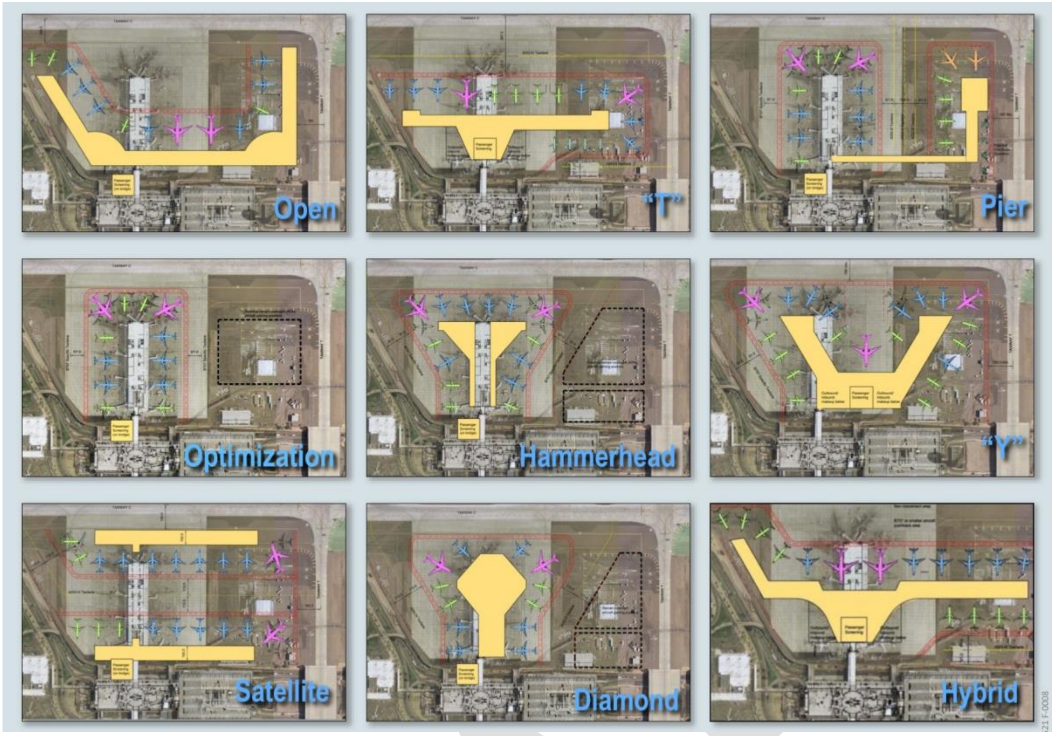
3.2.5 Terminal Concept Evaluation and Selection

Methods for evaluating and selecting a preferred passenger terminal concept are described in the following sections.

3.2.5.1 Development and Evaluation of Initial Concepts

The initial investigation of alternative terminal concepts should include a high-level consideration of various terminal concepts and their variations and combinations (see Chapter 5, *Functional Relationships and Terminal Concepts)*. The purpose of this step is to identify the full range of potential options, rather than explore concepts in detail. For comparative purposes, alternatives should be developed using consistent criteria, including: aircraft fleet mix and wingtip spacing, terminal and concourse dimensions, relationship to the airfield, roadway network, other support facilities, and other site-specific criteria. Each alternative should be accompanied by a brief summary of the main points of consideration related to it. Alternative concepts at this stage in the planning process may be developed using criteria which could be revisited later and modified based upon input and discussions with stakeholders. **Figure 3-2** shows a variety of common conceptual terminal redevelopment alternatives.

Figure 3-2 Example of Initial Conceptual Terminal Alternatives



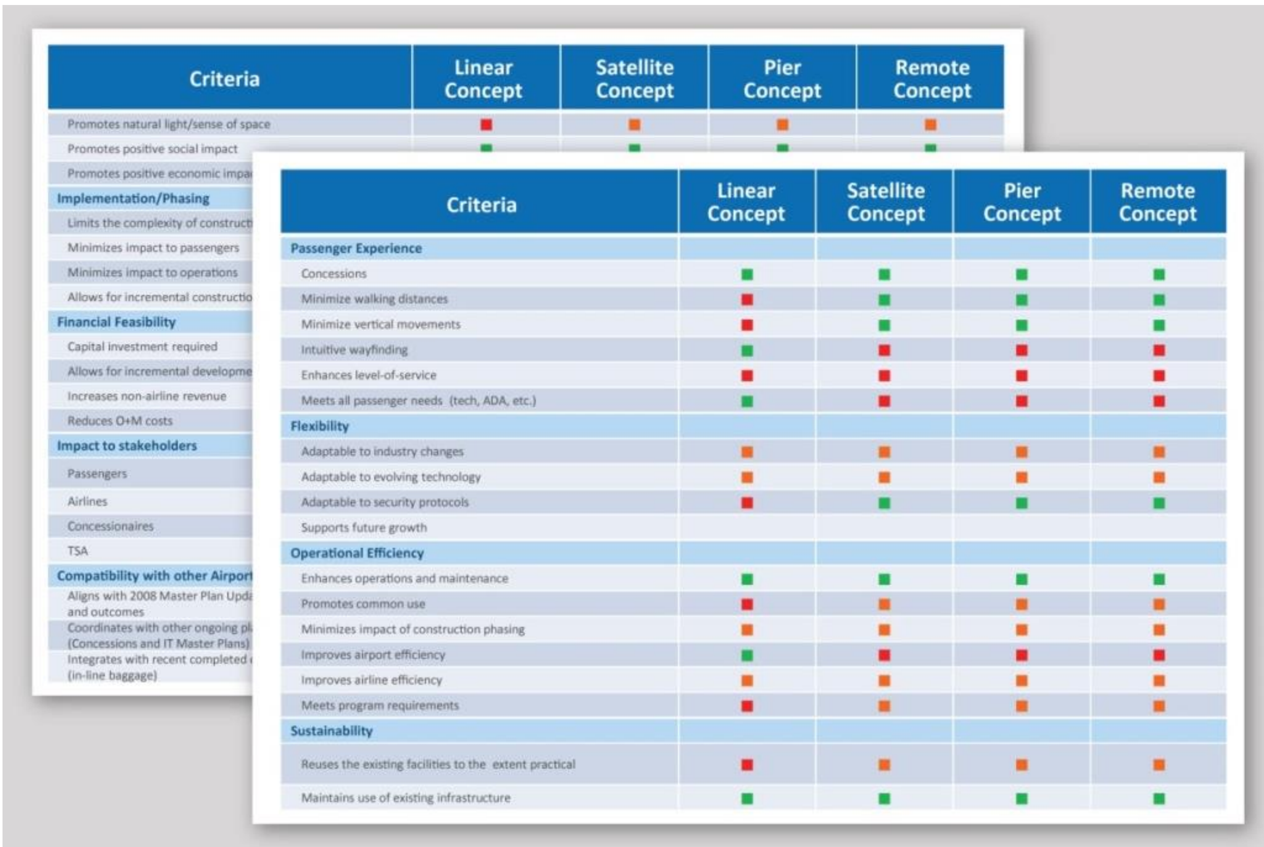
The following three-step process can be used to objectively evaluate the concepts against one another and reduce the number of conceptual terminal alternatives to a smaller group of shortlisted concepts for further refinement and evaluation:

1. **Identify Evaluation Criteria**. Develop evaluation criteria that represent the *essential* factors to be considered in determining the preferred replacement, new terminal, and rehabilitation or expansion alternatives for the airport. The criteria and definitions should be carefully tailored to match the goals, objectives, and other parameters established earlier in the project. Initial criteria may include economic viability, airside access, ability to accommodate terminal growth and expansion, walking distances, landside access availability, operational flexibility, site availability, airspace impacts, Airport Traffic Control Tower (ATCT) line-of-sight, environmental issues, constructability, schedule, and order-of-magnitude costs.
2. **Establish Weighting**. Next, develop weighting factors, which may be assigned to each evaluation criterion according to relative importance. The weighting should be developed with input from stakeholders and consider priorities in relation to goals and objectives identified earlier in the process.
3. **Perform a Technical Ranking**. Develop a matrix or other framework for ranking the concepts against each criterion. The ranking should represent majority consensus among stakeholders. One possible ranking scheme utilizes rankings of positive, neutral or negative for each criterion.

The score for each alternative is the sum of all weighted factors identified for the criteria listed. This process can be repeated with more direct weighting or second tier criteria in order to reduce a large number of potential alternatives to a more manageable number.

A concept evaluation matrix which includes generalized evaluation criteria and definitions used in the preliminary evaluation process is presented in **Figure 3-3**. In the example provided, positive, neutral, and negative rankings are indicated by green, orange, and red squares, respectively.

Figure 3-3 Example Preliminary Evaluation Matrix



Criteria	Linear Concept	Satellite Concept	Pier Concept	Remote Concept
Passenger Experience				
Concessions	Green	Green	Green	Green
Minimize walking distances	Red	Green	Green	Green
Minimize vertical movements	Red	Green	Green	Green
Intuitive wayfinding	Green	Red	Red	Red
Enhances level-of-service	Red	Red	Red	Red
Meets all passenger needs (tech, ADA, etc.)	Green	Red	Red	Red
Flexibility				
Adaptable to industry changes	Orange	Orange	Orange	Orange
Adaptable to evolving technology	Orange	Orange	Orange	Orange
Adaptable to security protocols	Red	Green	Green	Green
Supports future growth				
Operational Efficiency				
Enhances operations and maintenance	Green	Green	Green	Green
Promotes common use	Red	Orange	Orange	Orange
Minimizes impact of construction phasing	Orange	Orange	Orange	Orange
Improves airport efficiency	Green	Red	Red	Red
Improves airline efficiency	Orange	Orange	Orange	Orange
Meets program requirements	Red	Orange	Orange	Orange
Sustainability				
Reuses the existing facilities to the extent practical	Red	Orange	Orange	Orange
Maintains use of existing infrastructure	Green	Green	Green	Green

3.2.5.2 Shortlisted Concepts

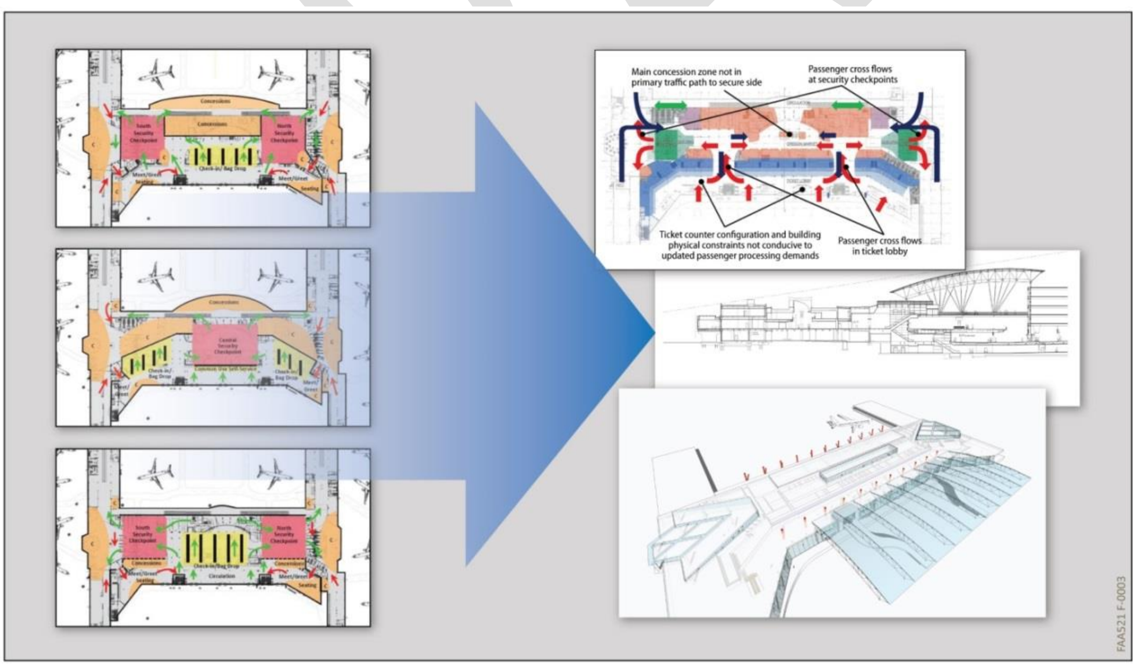
Following the identification of shortlisted terminal alternatives, the conceptual terminal plans should be redrawn at a larger scale (greater level of detail) with specific functional areas shown in order to provide additional detail and allow a more detailed evaluation of each concept. This refinement is prudent because of the following:

- Establishes the conformity of each concept to the goals and objectives.
- Closely examines the ability of each concept to satisfy demand and the functional and operational requirements of airlines, passengers, tenants, automobiles, and other elements.
- Ensures each concept can be sufficiently phased without causing significant disruption to airport operations.
- Allows for the preparation of order-of-magnitude costs and financial feasibility assessments of each concept.

Brief narrative descriptions of each shortlisted terminal concept (and potential variations) should be written. A cross section of each alternative may also be prepared to define the process of passenger movement, baggage routing, and other information. An example of this detail is shown in **Figure 3-4**.

Phasing is a key component of the evaluation process and requires careful attention and effort. The ability to phase a proposed conceptual terminal plan is essential to the concept's viability. The evaluation of phasing will require coordinated input from airport staff and the critical stakeholders as any flaw in the logic or acceptance of the phasing plan could jeopardize the concept and planning investment. This analysis should include team members with design, construction, and operational experience, as their input can help determine the feasibility of phasing plans.

Figure 3-4 Examples of Prototypical Shortlisted Terminal Concepts



3.2.5.3 Refined Evaluation

For each of the shortlisted terminal concepts that are developed in additional detail, the initial evaluation criteria should be revisited and reassembled in a new matrix (potentially with new or refined criteria) to complete the evaluation. A simplified scoring system may be used in this secondary concept evaluation. The system could be simple – such as assigning positive, neutral, or negative labels to each alternative based on specific criteria; or more elaborate systems could be developed, such as allocating points to each alternative based on the criteria. **Figure 3-5** shows an example of a secondary evaluation matrix.

Figure 3-5 Example Secondary Evaluation Matrix

Criteria	Concept A: Dual Checkpoint	Concept B: Centralized Checkpoint
Passenger Experience		
Concessions	Green	Green
Minimize walking distances	Red	Green
Minimize vertical movements	Red	Green
Intuitive wayfinding	Green	Red
Enhances level-of-service	Red	Red
Meets all passenger needs (tech, ADA, etc.)	Green	Red
Flexibility		
Adaptable to industry changes	Orange	Orange
Adaptable to evolving technology	Orange	Orange
Adaptable to security protocols	Red	Green
Supports future growth		
Operational Efficiency		
Enhances operations and maintenance	Green	Green
Promotes common use	Red	Orange
Minimizes impact of construction phasing	Orange	Orange
Improves airport efficiency	Green	Red
Improves airline efficiency	Orange	Orange
Meets program requirements	Red	Orange
Sustainability		
Reuses the existing facilities to the extent practical	Red	Orange
Maintains use of existing infrastructure	Green	Green
Promotes natural light/sense of space	Red	Orange
Promotes positive social impact	Green	Green
Promotes positive economic impact	Green	Red
Implementation/Phasing		
Limits the complexity of construction	Red	
Minimizes impact to passengers	Green	Green
Minimizes impact to operations		
Allows for incremental construction/phases	Green	Red
Financial Feasibility		
Capital investment required	Green	Green
Allows for incremental development	Green	
Increases non-airline revenue		
Reduces O+M costs		
Impact to stakeholders		
Passengers		Orange
Airlines		
Concessionaires		
TSA		
Compatibility with other Airport projects		
Aligns with 2008 Master Plan Update objectives and outcomes		
Coordinates with other ongoing planning efforts (Concessions and IT Master Plans)		Red
Integrates with recent completed or proposed projects (in-line baggage)		

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The result of the evaluation process should be represented graphically so that the recommended development concept, phasing, schedule and other key details can be readily understood. This is particularly important if the recommended approach combines several elements of the shortlisted alternatives.

3.2.5.4 Financial Feasibility

Using rough order of magnitude (ROM) cost estimates, the planning team should considerer financial planning factors to confirm the economic viability of terminal concepts. An analysis of the financial feasibility of each proposed concept investigated in parallel with the development of alternatives and evaluation will be a key factor in selecting the preferred alternative. A second round of financial feasibility should occur once the preferred alternative is selected as part of the evaluation process.

3.2.6 Preferred Terminal Development Concept

Once a preferred terminal development concept is identified, the concept should be clearly delineated in plans, cross-sections, perspectives, program fit, and descriptive narrative. This delineation should also address the original planning parameters, site constraints, and other criteria set out at the initiation of the study. A narrative prepared for the preferred terminal concept should describe the process, the resulting recommendation and cover major points, such as:

- Achieving balanced capacities (e.g., the passenger curbfront should support the number of passengers that the aircraft gates can accommodate).
- Overall flexibility of space within the terminal building.
- Revenue enhancement opportunities.
- Operational flexibility for airlines and concessionaires.
- Flexibility to adapt to industry changes and future considerations.
- Ease of ground transportation access.
- Phasing of terminal improvements.

The implementation of the preferred terminal concept may need to be a multi-phased development extending over a significant period of time. A multi-phased approach may be necessary for several important reasons including, but not limited to:

- The need to retain a minimum number of operational aircraft gates at all times during construction.
- The need to maintain existing terminal building systems and equipment in operation during all phases.
- The potential requirement that a substantial portion of the new terminal may need to be built on the same site as the existing terminal facility.
- The need to preserve the safety of passengers, vehicles, personnel, and aircraft during all phases of construction.
- Other factors related to cost, affordability, climate, and seasonal construction variables.

Finally, there are a number of elements which will continue to be evaluated as the planning evolves. As the terminal concept moves into design this evolutionary evaluation process will continue until all of the elements are set. Elements which may continue to be considered within the preferred terminal concept are alternative plans for baggage processing, concessions, passenger processing, concourse phasing, aircraft parking and departure holdrooms.

3.2.7 Documentation

Clear and concise documentation is critical to the success of the overall planning process and ultimately to the successful transition to design and implementation phases. There are four primary objectives of the documentation process:

1. **Clearly document the understanding and consensus of all planning team members**. This documentation should include all of the initial assumptions, and a clear record of the process steps and decisions. Clear documentation of changes in direction during the process should also be documented as stakeholders will need to understand the rationale for the conclusions. The final recommendations will need to be thoroughly documented in a final report. This document will be used by project teams in the implementation phases that may or may not include members of the planning team, although ideally the planning team would continue to be involved in an advisory capacity through the design and implementation phases.

2. **Provide communication tools to convey, educate, and advocate with parties outside of the planning team**. These tools will be derived from the detailed documentation described above, but will be a simplification or executive summary that conveys the fundamental program goals and direction to parties outside of the planning team. Typical approaches to outreach can include executive briefing documents, presentation brochures, social media, project websites and other multi-media formats. The exhibits for these documents will require a more polished, less technical approach for successful communication to audiences with less knowledge of terminal and airport facilities.

3. **Establish a "living" base document as the schedule for the program.** Airport development projects can potentially continue for decades depending on the outcome of the planning process. Critical to the implementation of the proposed program, documentation must be produced that focuses on the assumptions and decisions made during the planning process, open issues that remain regarding the proposed preferred alternative, and future options, alternatives and key decisions that will be necessary as the project moves forward. Due to the continually changing dynamics of the aviation industry as discussed above, the 'owners' of the program as it progresses will need to be provided with a roadmap that has sufficient flexibility to adapt the recommendations to future conditions without sacrificing the goals and objectives of the airport operator.

4. **Define the preferred alternative sufficiently to enable follow-on work necessary to implement the improvements**. Sufficient definition will allow subsequent work such as environmental review and permitting, as well as architectural/engineering design to proceed without revisiting major planning parameters. A planning step referred to as "program definition" is oftentimes used following a terminal planning study, to establish firm planning, design, schedule and budget parameters for the designers to follow. This can be an extensive process, but one that can save the airport owner significant amounts of time, money, and confusion. Documentation should be prepared in alignment with what is needed for NEPA review.

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CHAPTER 4. PLANNING AND DESIGN METHODOLOGIES AND TOOLS

4.1 General

This chapter provides a discussion of methods and tools used to support the terminal planning and design process. Key items described in this chapter include demand characteristics and analytical tools.

Demand levels and characteristics are generally researched and established early on in the process, as they represent basic data needed to conduct a terminal planning or design effort. Analytical tools are used later in the process to determine terminal facility needs and sizing.

4.2 Demand Characteristics

Demand forecasts are developed to estimate future passenger activity and aircraft operations levels. Preparation of annual activity and the conversion of demand into planning activity levels are addressed in Chapter 3, *Terminal Planning and Design Process* (facility requirements and other terminal space programs should be linked to annual "activity milestones" that are defined in terms of planning activity levels rather than future calendar years). Peak demand levels (e.g., busiest day of the year, Peak Hour of the Average Day of the Peak Month) are derived from annual activity and are the basis upon which terminal space programs are normally developed. It is important to ensure that activity being forecast is related to the problem being addressed. The following describes basic activity characteristics and traditional methodologies to determine them.

4.2.1 Annual Activity

Annual activity can be used to determine order-of-magnitude facility requirements. Annual forecast data relevant to the terminal planning process includes the following:

- Passenger enplanements – the annual number of departing passengers using a terminal facility. Enplanements can be subcategorized by domestic and international, originating or connecting, or any other category depending on project need. Annual enplanements can be used to calculate order-of-magnitude facility requirements for terminal areas associated with departing passengers.
- Passenger deplanements – the annual number of arriving passengers using a terminal facility. Deplanements can be subcategorized by domestic and international, terminating or connecting, or other categories depending on the project need. Annual deplanements can be used to calculate order-of-magnitude facility requirements for terminal areas associated with arriving passengers.
- Aircraft operations – the annual number of arriving and departing aircraft that utilize the terminal facility. Aircraft operations can also be subcategorized by domestic and international, and wide-body versus narrow-body aircraft. Annual aircraft operations can be used to calculate order-of-magnitude gate requirements.
- Aircraft fleet mix – the specific types of aircraft serving an airport. Fleet mix is important because different aircraft have different passenger capacities (i.e., number of seats). Aircraft fleet mix can be used to calculate order-of-magnitude gate requirements and determine the flexibility of a proposed aircraft parking layout.

- Load factor – the percentage of seats utilized on an aircraft; can be determined and expressed individually for specific airlines or type of operation (e.g., international or domestic), or as an average of all aircraft operations at an airport.

To determine more refined requirements and other terminal space programs, annual forecasts are typically translated to peak daily and hourly demand.

4.2.2 Peak Activity

Peak activity refers to the highest level of passenger or operational activity that is projected to occur, and is normally expressed as peak month, day, or hour. Terminal facility planning requires knowledge of peak activity because the space program is based on projected peak volumes of passengers. For example, the number of lanes required for a security screening checkpoint is based on the maximum throughput of an individual screening lane. If there are 300 passengers in the peak hour and each lane can process 150 passengers per hour, then a minimum of two screening lanes are needed. Chapter 6, *Terminal Building Space Program* describes the relationship of peak activity to building a space program for each terminal functional area. Depending on the level of analysis required, peak activity data can be prepared for passenger enplanements and deplanements (and associated sub classifications), and aircraft operations.

Publications that provide guidance on forecasting and peaking calculations, include:

- FAA Guidelines, *Forecasting Aviation Activity by Airport*
- ACRP Synthesis Report 2, *Airport Aviation Activity Forecasting*
- ACRP Report 82, *Preparing Peak Period and Operational Profiles—Guidebook*

Average Day of the Peak Month (ADPM) is a common methodology used to identify existing and forecast future peak activity. The peak month is the month representing the highest percentage of total annual activity; and ADPM is determined by dividing the peak month's activity by the total number of days in that month. Future ADPM is determined by multiplying forecast annual activity by the historic percentage of total activity in the peak month, and again, dividing by the total number of days in that month. The process of determining existing and forecast ADPM is shown in **Figure 4-1** below.

Figure 4-1 Determination of Average Day Peak Month Activity

Month	Activity	% of total
January	10,000	6%
February	12,000	7.8%
March	11,000	7.1%
April	12,500	8.1%
May	13,000	8.4%
June	14,000	9.1%
July	16,000	10.4%
August	15,500	10.1%
September	15,000	9.7%
October	12,000	7.8%
November	12,000	7.8%
December	11,000	7.1%
Annual total	**154,000**	100%

Determination of Existing ADPM	
Peak month activity =	16,000
Average day activity = (16,000 / 31 days)	516

Determination of Forecast ADPM	
Forecast annual activity =	200,000
Forecast peak month activity = (200,000 x 10.4%)	20,800
Forecast average day activity = (20,800 / 31 days)	671

4.2.3 Design Day Flight Schedules

Another method used to determine future peak activity is through the development of a "design day" flight schedule. A design day flight schedule differs from a calculated peak activity number derived from annual activity because it is based on an actual theoretical day, or rather, based on existing/current airline and passenger characteristics, such as:

- Airline flights – scheduled commercial aviation activity, by each airline.
- Airline fleet mix – aircraft types used by each airline.
- Airline load factors – historical data that represents percentages of seats occupied, per each airline flight.
- Passenger type – percentage of passengers types such as families, business travelers, leisure travelers, prescreened travelers, and passengers with elite airline status.

An existing design day flight schedule provides a distribution of passengers on an hourly basis throughout the design day. The peak hour can therefore be identified as the hour in the schedule that includes the highest passenger volumes for a given function, such as enplaning passengers, connecting passengers, and international passengers.

Future peak hour volumes are thereby determined by applying appropriate growth rates to the existing design day flight schedule and increasing the activity levels to match forecast demand. This can be accomplished via a combination of "up-gauging" (utilizing larger aircraft with higher numbers of seats per plane) aircraft types and/or the introduction of additional flights, depending on the strategies most likely to be deployed by the individual airlines at the airport. Coordinate with air carriers to validate and tailor assumptions used in the development of the future schedule.

Industry resources that provide additional information for determining annual and peak activity include:

- ACRP Report 23, *Airport Passenger-Related Processing Rates*
- ACRP Report 25, *Airport Passenger Terminal Planning and Design*

4.3 Analytical Tools

A variety of analytical tools are available to assist in developing a terminal building space program. Three general levels of analysis – quick-estimation methods, macroscopic methods, and microsimulation methods – can be used to generate requirements. Each of these three methods differs in terms of the level of effort to perform the analysis: the level of accuracy or reliability of the results, and the required level of user expertise. The following briefly describes each method and when each should be applied.

4.3.1 Quick-Estimation Methods

Quick-estimation methods are best applied in early, conceptual stages of planning. They are used to develop a high-level terminal space program. Generally, broad assumptions or rules-of-thumb are inputs to a simplistic model that are used to determine facility requirements. At this low level of detail, a physical design is not needed. Typically, the outputs are in tabular form and the methods are used as initial screening criteria to determine whether or not a space program can be accommodated within the allowable development area; and therefore, if further analysis is warranted. The International Air Transport Association (IATA), *Airport Development Reference Manual* contains rules-of-thumb for the following facilities: check in, passport control, centralized security check, gate area hold rooms, bag claim units and arrival hall. Gross area terminal planning factors are also contained in ACRP Report 25, *Airport Passenger Terminal Planning and Design*, Volume 1, which can be a useful tool to consider rough terminal sizing.

4.3.2 Macroscopic Methods

Macroscopic methods are used to understand overall passenger, baggage, and vehicular flows. This level of modeling typically requires a design or concept which can be represented in a model environment, along with logical assumptions assigned to passenger activities. Model outputs can include renderings of the simulation, including passenger routes, flows at processing points, and numerical outputs. Macroscopic methods can be used to generate a reasonable planning or design-level space program. These methods are fairly sophisticated, but require less time and experience than microsimulation methods. Macroscopic methods are most useful during a terminal planning conceptual design phase when developing a comprehensive space program, as opposed to a detailed focus on one specific functional area. ACRP Report 25, *Airport Passenger Terminal Planning and Design – Volume 2 Spreadsheet Models and User's Guide*, includes a spreadsheet model that is useful for this level of analysis, covering many of the functional terminal components.

4.3.3 Microscopic Methods

Microscopic methods involve sophisticated computer software that simulates individual passenger, baggage, and vehicle movements and their interaction with each other. This level provides the most realistic passenger movement simulations and includes passenger interactions, detailed queuing/movements and other passenger characteristics and behaviors that increase the level of accuracy. Outputs from this method can be 3-dimensional visualization images or videos for use in presentations. Microscopic methods are the most complex; and therefore require the highest level of experience to use and the maximum level of effort to produce results. These methods are best applied for analyzing micro-operational improvements such as solving security checkpoint congestion issues when expansion outside the building envelope is not an alternative. This method can also be useful in producing materials for high-profile presentations.

4.3.4 Other Tools

There are a variety of proprietary analytical models that have been developed over the last few decades that fit into one or more of the analytical categories above. Each terminal planning or design project is unique and the advantages, disadvantages, and desired outputs of each analytical tool should be understood prior to their application.

A few recognized analytical tools for terminal space programs are described in:

- ACRP Report 23, *Airport Passenger-Related Processing Rates*
- ACRP Report 25, *Airport Passenger Terminal Planning and Design*

There are also a variety of proprietary tools for producing an efficient terminal layout. Most of these are computer aided design software programs. These programs are dimensionally accurate and graphically show spatial relationships inside the terminal building. These programs can also be used for aircraft parking and simulation or 3-dimensional visualization. These tools can be used at all stages of terminal planning and design.

CHAPTER 5. FUNCTIONAL RELATIONSHIPS AND TERMINAL CONCEPTS

5.1 General

This chapter describes; how the passenger terminal has evolved over time, the various passenger terminal components and their functional relationships, and basic terminal concepts and configurations.

From the perspective of the terminal planning and design process, it is advantageous for an airport owner/operator, or those who are assisting in the process, to form some understanding early in the process how terminals have evolved. This understanding provides context for the project they are about to initiate. It is also important to understand the various functional components of a terminal complex and how passengers, vehicles, etc. move through the terminal complex. Finally, since some of those functions and processes are constantly evolving, it is important for those involved in planning and design to learn about those changes and how they may affect the plan.

5.2 Evolution of the Passenger Terminal

Airport terminal facilities have evolved considerably, along with the air travel industry. This section describes these changes (providing context for older terminals) and suggests how current trends are influencing modern facilities.

Airport terminals have evolved in step with the demands of the commercial aviation industry, which is over 100 years old. Despite their relative "newness," airport terminals have assumed a significant place in the lives of United States citizens, many of whom travel regularly by air. Expectations of the scale and grandeur of airport terminals grew as local governments came to increasingly regard airports as iconic symbols of their status and economic power, fulfilling a position much as did grand railway stations of the 19th Century.

The earliest terminals in the United States date from the late 1920s, when commercial aviation was in its infancy. The relatively high price and limited availability of air travel meant that it primarily served the wealthy elite. Most commercial flights provided a level of service well into the 1950s that would now be considered "First Class." This was the same era when airports were major civic and even national symbols. Designs were often tailored to meet the needs of a particular airline, and aesthetic considerations predominated over functionality and flexibility – a trend that would reverse in the 1960s.

Between 1960 and 1970, the number of air passengers in the United States increased 173%, the largest percentage increase ever for a single decade in United States aviation history. At the same time most airline fleets converted to jets. Jet aircraft evolved from the B707/DC-8/CV880-990 in the early 1960s (typical capacity of 125 to 150 passengers) to the B747-100 in 1969 (typical capacity of 350 to 450 passengers depending on the cabin configuration).

Larger capacity jet aircraft increased demands on terminal buildings. Greater efficiency and flexibility were needed to accommodate more passengers and baggage. Terminal buildings had to move beyond niche designs to vast "processors" capable of handling thousands of passengers and their baggage during peak periods. Airport terminal planners of the 1960s had few guidelines to follow, so experimentation was the rule. From the perspective of the early 21st Century we are able to look back and see which terminal designs worked and which did not; which proved flexible enough to grow with demand, and which were inflexible to change.

The Airline Deregulation Act of 1978, which removed restrictions on entry, pricing, and routes, had the greatest impact on the commercial aviation industry and ultimately on the planning and design of terminal facilities. Between 1978 and 1985, the number of non-commuter airlines increased from 43 to 87; the number of revenue passenger miles almost doubled; and the share of total traffic of the incumbent major airlines declined from 94% to 77%. Commuter and regional airlines (operating aircraft with fewer than 60 seats) increased their revenue passenger miles by a factor of seven between 1979 and 1989.

Deregulation also saw the emergence of two trends that directly affected terminal planning: the development of airline hubs and the introduction of low-cost carriers. While hubbing did exist prior to deregulation, building routes through hubs was a slow bureaucratic process. After deregulation, hub routing could be established quickly and the impact on terminals was dramatic. Hubs had to accommodate much higher peak volumes of passengers than originally planned, and most of these passengers needed to connect to other flights. The development of “banks” of flights (busy times of the day when many flights arrive and depart in a short window), significantly impacted aircraft maneuvering in the terminal area as well as airfield capacity. Passenger security screening, already required prior to deregulation, had to be redesigned in order to avoid connecting passengers having to go through screening again at a hub.

Deregulation also saw the advent of low-cost carriers, which is an airline business model based on short-haul, high-frequency service that bypasses hubs, and the use of a single aircraft type. Although some low-cost carriers establish “focus cities,” which allow passengers to make connections, the scheduling of flights is not based on concentrated banks of flights. This resulted in more continuous use of the terminal facilities throughout the day. In addition, these carriers’ insistence on low costs caused some airport operators to reconsider how they designed and operated terminals. Many low-cost carrier operating concepts, such as not serving in-flight meals, came to be adopted by legacy carriers. As a result airports have increased food concessions throughout the terminal.

During the early 1990s, higher fuel costs combined with a global recession and increased industry capacity caused the financial failure of a number of new and long-established airlines. Airlines also continued to consolidate after 2000 as competitive price pressure intensified. These actions, combined with the introduction of smaller capacity regional jet aircraft and the new large capacity A380 caused dramatic changes to the airline industry, airport terminals, and terminal planning.

The industry landscape is expected to continue to shift as airlines change their operating procedures and markets. This likelihood places a premium on flexibility in terminal design. Terminal planning and design guidelines will always have a limited life and need to be re-evaluated periodically to reflect developing trends. On a cautionary note, history shows that not all trends survive; terminal planners and designers need to look at the latest “next big thing” carefully before basing a terminal concept on it.

5.3 Originating and Destination Versus Hub / Connecting Markets

There are vast differences between a passenger terminal that is primarily suited for originating and destination passengers (O&D), and one that is suited for accommodating connecting or airline hub operations. In the United States, O&D markets typically have high peak hour enplanements in the morning hours, and high peak hour deplanements in evening hours. Since the terminal size is driven by peak activity, the terminal facility can be relatively underutilized during the remainder of the day. Since it is not practical to keep aircraft at the gate overnight, O&D markets also include high demand for Remain Overnight (RON) aircraft parking positions that can impact the planning and design of airside facilities. This RON requirement also tends to facilitate maintenance operations at O&D airports and therefore hangar space becomes an important planning component nearby the terminal complex.

Finally, O&D airports generally also require more curbside and parking facilities, particularly close to the terminal, to accommodate the enplaning and deplaning peaks.

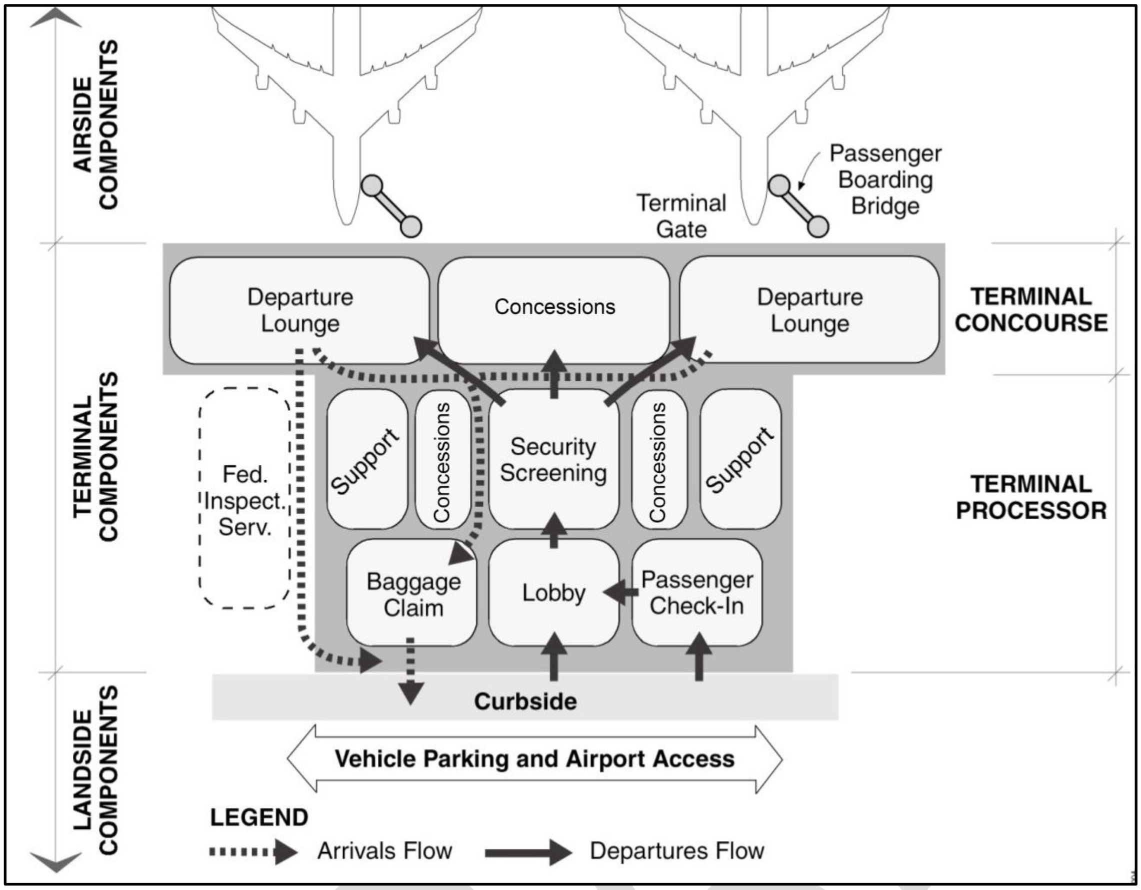
Airports with significant connecting or hubbing operations have O&D morning and evening peaks that accommodate the local market, but also significant mid-day activity when connecting activity generally peaks. For this reason, hub airport terminals generally have higher levels of passenger activity throughout the day and therefore, better efficiency in the use of facilities. Concessions also play a more important role in passenger service and revenue generation due to the longer time passengers spend in the terminal while connecting. Compared to O&D markets, demand for curbside and parking facilities is reduced since a large percentage of passengers are not local; and demand for RON parking positions is also diminished because aircraft are generally positioned at the O&D facilities overnight.

5.4 Terminal Components and Functional Relationships

The terminal complex can be defined as the interface between aircraft, travelers, and the landside transportation, which cohesively work to efficiently convey passengers to and from their origins and destinations. Viewed this way, the terminal complex can be divided into three primary components: airside, terminal building and landside. **Figure 5-1** shows the sequence of flow between the various components in a typical terminal complex from curbside to aircraft parking. It should be noted that not every terminal provides for all of these functions or that each function must have a separate area. For example, at low-activity airports, one general space may contain multiple functions, such as a lobby, ticket counters, and waiting lounge.

The primary users of airport terminals are airlines, travelers, well-wishers, meeters/greeters, and a wide range of employees of air carriers, concessionaires, government regulatory authorities, airport management, and other airport tenants. While terminal facilities must accommodate all these users, the planning and design of a terminal facility is primarily influenced by the activities within the terminal building, which can be categorized into the following functions: (1) processing and servicing passengers, (2) handling and processing of belly cargo (including passenger baggage), (3) aircraft servicing, and (4) facility support and utility functions. Consequently, good terminal design requires a layout that locates the various components in a sequence or pattern that reflects the natural movement and services each requires, and those activities and operations that functionally depend on each other. Such a design minimizes passenger walking distances, airline servicing and processing times, and congestion that can be caused by the convergence of unrelated activities.

Figure 5-1 Terminal Components



5.4.1 Airside Components

Airside terminal facilities (see **Figure 5-1**) primarily include the area and facilities required to accommodate aircraft parking and aircraft support and servicing operations. They include:

- Terminal gates or "contact" parking positions – this portion of the apron is used for parking aircraft to enplane and deplane passengers via passenger boarding bridges (PBB) that are part of the gate position and connected to the terminal building.
- Remote aircraft parking positions – used for parking aircraft to enplane and deplane passengers; passengers are transferred from the terminal to the aircraft (or vice versa) via bus or other passenger transport vehicle, secure pedestrian walkway, or simply by walking to the aircraft.
- Aircraft deicing positions – deicing operations can be conducted at the terminal gate, in a position pushed back from the gate, at a remote location (i.e. a hardstand) or on a dedicated aircraft deicing apron. Dedicated areas accommodate the aircraft and typically have space available for the staging of deicing equipment for efficient and safe operations and also have a system to recapture deicing fluid overspray on the ground (e.g. trench drains, glycol recovery vehicles, etc.).

- Aircraft service areas – on or adjacent to the aircraft parking position used by service personnel for servicing aircraft and for the staging of baggage, freight, and other ground service equipment (GSE) for loading and unloading the aircraft.
- Taxilanes – portion of the apron area that provides taxiing aircraft with access between airfield elements (e.g., taxiway and runway) and aircraft parking positions.
- Aircraft maneuvering and pushback areas and necessary wingtip clearances.
- Service/security/and emergency response areas – reserved areas or rights-of-ways for hydrant fueling systems, GSE and emergency response vehicles, fire suppression devices, maneuvering, staging and storage, security, and blast fences.
- Vehicle Service roads – enable the safe movement of vehicles around the airfield minimizing interaction with aircraft.
- Other equipment - aircraft waste dump/triturator station, electric vehicle charging stations, etc.

The airside's large spatial requirements and fixed requirements for aircraft wingtip separations and maneuvering clearances typically drive the layout of the terminal complex more than either the passenger processing requirements within the terminal building, or its adjacent landside components. For most terminal planning and design projects, it is important from the outset to formulate solutions based on the airside component. This requires identifying gate requirements and locating aircraft parking positions and their supporting taxilanes so that the overall efficiency of the airfield is optimized prior to planning the internal layout of the terminal building and the landside curb and terminal roadway systems.

5.4.2 Terminal Components

Terminal components (see **Figure 5-1**) include two main elements – the terminal "processor" and the terminal concourse. The terminal processor typically includes these components:

- Public circulation and lobbies – public areas for passenger circulation, services, and passenger/visitor waiting; also can include areas for general circulation which include stairways, escalators, elevators, and corridors.
- Passenger check-in – areas used for ticket transactions, baggage check-in, flight information, and space for airline administrative functions.
- Security screening – a control point for passenger and carry-on baggage inspection, and controlling public access to sterile areas of the terminal. This area also typically includes offices and support areas for administration, security staff, airport police and emergency response staff. Checkpoints are typically situated after the passenger check-in/ticketing lobby. However, some facilities have "front-of-house" security screening checkpoints, where airport users must clear security prior to entering the building.
- Federal Inspection Services (FIS) – a control point for processing passengers arriving on international flights.
- Baggage processing – a nonpublic area for sorting, processing, and screening baggage for departing flights and baggage transfers from one flight to another.
- Inbound baggage facility – divided by a nonpublic area for receiving and sorting baggage from arriving flights, and public areas for baggage pickup by arriving passengers (e.g., baggage claim) and airline baggage service offices.

- Other tenant space – areas reserved for ground operators, rental car agencies, United Service Organizations (USO), etc.

In a simplified definition, the terminal concourse is essentially a passageway between the terminal processor and the aircraft gates. However, the concourse is the area of the terminal complex where passengers spend the majority of their time. The following elements typically comprise the terminal concourse:

- Passenger boarding bridge – the structure(s) and/or facilities normally located between the aircraft gate position and the concourse structure, enabling the enplaning and deplaning of passengers.
- Departure lounge – an area for assembling and holding passengers prior to a flight departure.
- Circulation corridors – public areas that facilitate the movement of passengers from the terminal processor to the departure lounge; the area and movement of passengers can often be facilitated via moving walkways, elevators, escalators, or people movers.

The following elements can be located in both the terminal processor and the concourse:

- Airline operational areas – areas set aside for airline personnel, equipment, and servicing activities related to aircraft arrivals and departures.
- Passenger amenities – areas normally provided in both the terminal processor and concourse, particularly at larger airports. These amenities can include restrooms, concessions such as food and beverage and news/gift shops, airline lounges, children's play areas, pet relief areas, etc.
- Building maintenance and utilities – areas reserved for terminal building maintenance and janitorial functions, mechanical, electrical and plumbing (MEP) systems, information technology storage, etc.
- Terminal services – facilities, both public and nonpublic, which provide services incidental to aircraft flight operations, including food preparation and storage, truck service docks, and miscellaneous storage.
- Airport administration and services – areas dedicated to airport management, operations, and maintenance functions.

5.4.3 Landside Components

Landside terminal components (see **Figure 5-1**) primarily include the facilities and space required to enable ground ingress and egress to and from the airport terminal facility. These include:

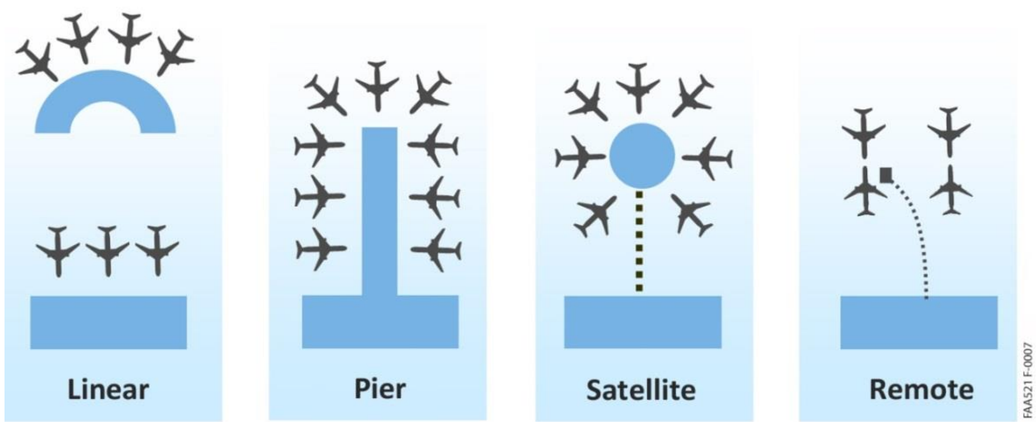
- Curbside – platforms and curb areas (including median strips) which provide passengers and visitors with vehicle loading and unloading areas adjacent to the terminal processor; includes areas reserved for both private and commercial vehicles.
- Pedestrian walkways – designated lanes and walkways for crossing airport roads, including tunnels and bridges which provide access between curbs, auto parking areas and the terminal.
- Automobile parking – short- and long-term parking for passengers, visitors, employees, and rental car concessionaires; can also include quick-stop cell phone lots for vehicles awaiting passenger arrivals and staging areas for taxis and rideshare vehicles.
- Access roadways – vehicular roadways providing access to the terminal curb, public and employee parking, and to the regional roadway/highway system.

- Rail and transit right of ways – access corridors that provide access to and from the terminal facility, airport parking, and associated airport facilities.
- Airport service roads – public and nonpublic roadways and fire lanes providing access to other elements of the terminal complex and other airport facilities, such as air freight, fuel facilities, taxi/limo, airport-related commercial development (e.g., airport hotel or gas stations), and security/maintenance areas.

5.5 Terminal Concepts and Configurations

Four basic terminal concepts are illustrated in **Figure 5-2** and described in the following sections. These concepts primarily differ in the way passengers move from the terminal processor to the aircraft gates. Specific dynamics of each include overall size, physical space and land configuration, as well as cost to operate. Although the following discussion focuses on the four basic concepts, many existing and planned airport terminals represent a “hybrid concept” where multiple combinations are utilized. The planning team would typically begin exploring the various concepts once the sizes of the functional components are determined and as they look at the realities of the building site and what fits. Efficiency in the operation of the terminal complex is an overarching concept at this stage of the process.

Figure 5-2 Example Terminal Concepts



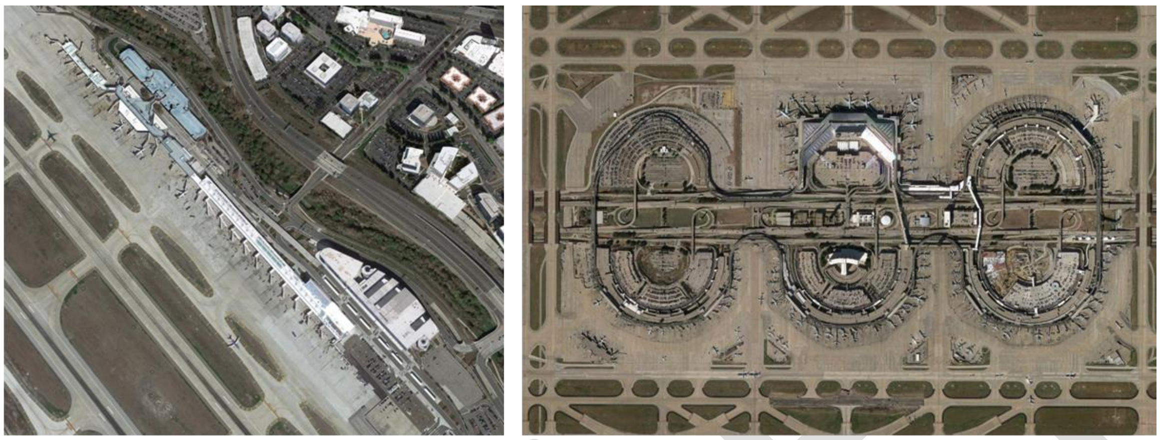
5.5.1 <u>Linear Terminal Concept</u>

Linear terminals are long buildings with aircraft parked perpendicularly along the airside face of the main terminal processor. There is expansion potential to either side, with the length primarily driven by the number of gates and their sizing requirements, but limited by walking distances. Typically, a concourse may be located parallel to or within the terminal face nearest the apron, with access to the terminal and aircraft gate positions at regular intervals. Linear terminal concepts provide easy passenger orientation, close-in public parking, long curb frontage, and flexible gate assignments (when module width is adequate). The layout usually minimizes walking distances for originating and terminating passengers, but not necessarily for connecting passengers.

With the advent of security checkpoints, the linear concept lost one of its main advantages – easy access and relatively short curb-to-gate walking distances for originating and/or terminating passengers. It is, however, still ideal for certain airports, primarily smaller terminal facilities serving largely O&D activity.

Airports with linear terminal concepts include San Jose and Dallas-Fort Worth international airports. See **Figure 5-3**.

Figure 5-3 Example Linear Terminal Concepts



San Jose International Airport

Dallas / Fort Worth International Airport

5.5.2 Pier Concept

In the pier concept aircraft are parked along piers or concourses extending from the terminal processor. Access to the terminal processor is provided at the base of the concourse or pier. Piers can have various shapes and aircraft can use both sides of the piers. Aircraft are usually arranged around the axis of the pier in a perpendicular nose-in position. Each pier typically has rows of aircraft gate positions on one or both sides, with circulation space running along the axis of the pier for enplaning and deplaning passengers.

In situations where available land is constrained, pier concepts utilize space efficiently although they may also cause longer passenger walking distances, potential conflicting passenger movements between arriving and departing passengers, and limited curbside space. However, the evolving downsizing of passenger processing space and the inherent efficiency of double-loaded concourses result in the pier configuration having relatively efficient terminal layouts.

Examples of pier concepts are found at La Guardia International, Washington Reagan National, Miami International, and Phoenix-Sky Harbor International airports. See **Figure 5-4**.

Figure 5-4 Example Pier Terminal Concepts

Miami International Airport

New York LaGuardia International Airport

5.5.3 Satellite Concept

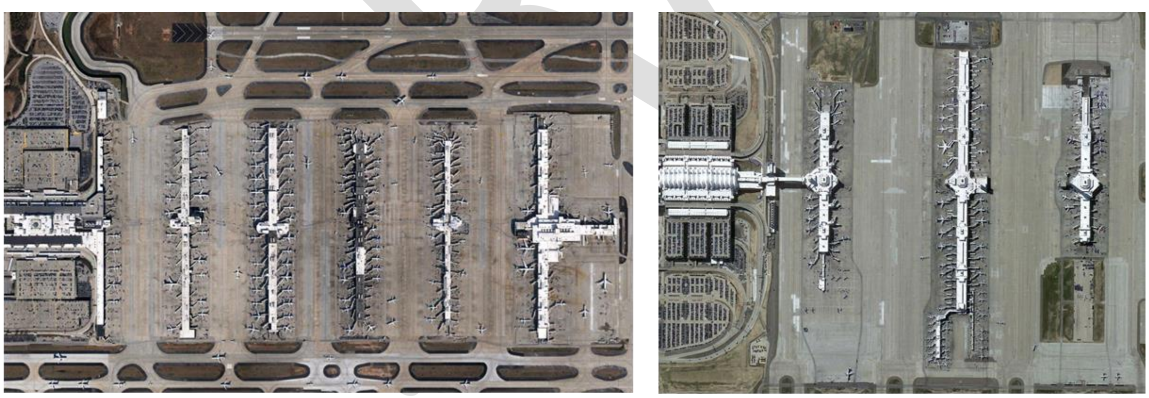
The satellite concept consists of a concourse (or concourses) and aircraft gates that are physically located apart from the main terminal processor. Since enplaning and deplaning of the aircraft is accomplished remote from the processor, satellite concepts require some type of connection between the concourse and terminal processor for the movement of passengers, baggage, and other materials. This connection can be accomplished via surface (e.g., busses, bridges, or Automated People Movers (APM)), underground (e.g. tunnel), or above-grade connections (e.g. bridge or APM). The provision of underground facilities for mechanical conveyance systems to move passengers, baggage, and other materials can add significant costs to the concept. On the other hand, the movement of passengers, baggage, and other goods via surface or above grade means can complicate and hinder the movement of aircraft and other vehicles on the airside.

The satellite concept provides good space utilization and is compatible with airports that have a high percentage of connecting traffic. Connecting operations do not require landside facilities, and therefore less passenger processing and curbside facilities are needed. However, satellite concepts can be inconvenient for connecting passengers who must connect between multiple satellites; and curbside congestion can also be a problem if the balance of O&D and connecting passengers is not properly taken into consideration.

Satellite concourses are also typically associated with higher operating and maintenance costs because redundant functions and facilities are required in both the terminal processor and auxiliary satellites (e.g., concessions, airline office space), and because of the physical distance between the processor and concourses. Satellite configurations also tend to be less intuitive with regard to wayfinding, which can challenge less experienced travelers.

Airports with satellite terminal concepts include Hartsfield-Jackson Atlanta International, Denver International, and Chicago O'Hare international airports. See **Figure 5-5**.

Figure 5-5 EXAMPLE SATELLITE TERMINAL CONCEPTS



Atlanta International Airport

Denver International Airport

5.5.4 Remote Concept

In the remote concept, aircraft and aircraft-servicing functions are accommodated in a remote location whereby the aircraft is not “connected” to a physical terminal or concourse. The connection between the aircraft and the terminal is provided by vehicular transport for enplaning and deplaning passengers, baggage, and other goods and personnel. Although this concept is common in European and South American airports, the use of the remote concept in the United States is fairly uncommon. The original remote concept envisioned the use of the transporter vehicle as the departure lounge although the common application today is a busing operation.

This concept provides a lower level of passenger service than the linear, pier, and satellite terminal concepts. However, the remote concept can be employed in conjunction with another terminal concept to increase short-term/temporary or permanent aircraft parking capacity. Due to the inherent reduced concourse requirements of the remote concept, it does result in an efficient terminal area configuration. The increased operating costs of the remote concept can, however, overshadow efficiencies provided by a smaller terminal facility.

5.5.5 Centralized and Decentralized Terminals

The main terminal processor for each of the above configurations may either be centralized or decentralized, depending upon how the concourse connector is extended or linked to the terminal processor. In a centralized concept, there is a single main terminal processor that accommodates all passengers, baggage, security, and other “processing”-related activities. In a decentralized concept, there are multiple terminal processors, often one serving each concourse, pier, or satellite concourse. Often a dominant carrier at an airport will dictate a multiple processor configuration to allow independent control of their facilities and operations. A significant international operation at an airport may also be a driver for a separate terminal due to the unique requirements and facility demands of international travel. However, changes in pre-clearance alternatives are beginning to blur the line between domestic and international operations at some airports and should be considered when planning for international operations. Multiple terminal facilities may present long-term challenges for the airport in that they are inherently less efficient due to the redundancy of space and functions, and lack of flexibility for airlines to grow, downsize, or relocate within the terminal complex.

5.6 Terminal Siting Considerations

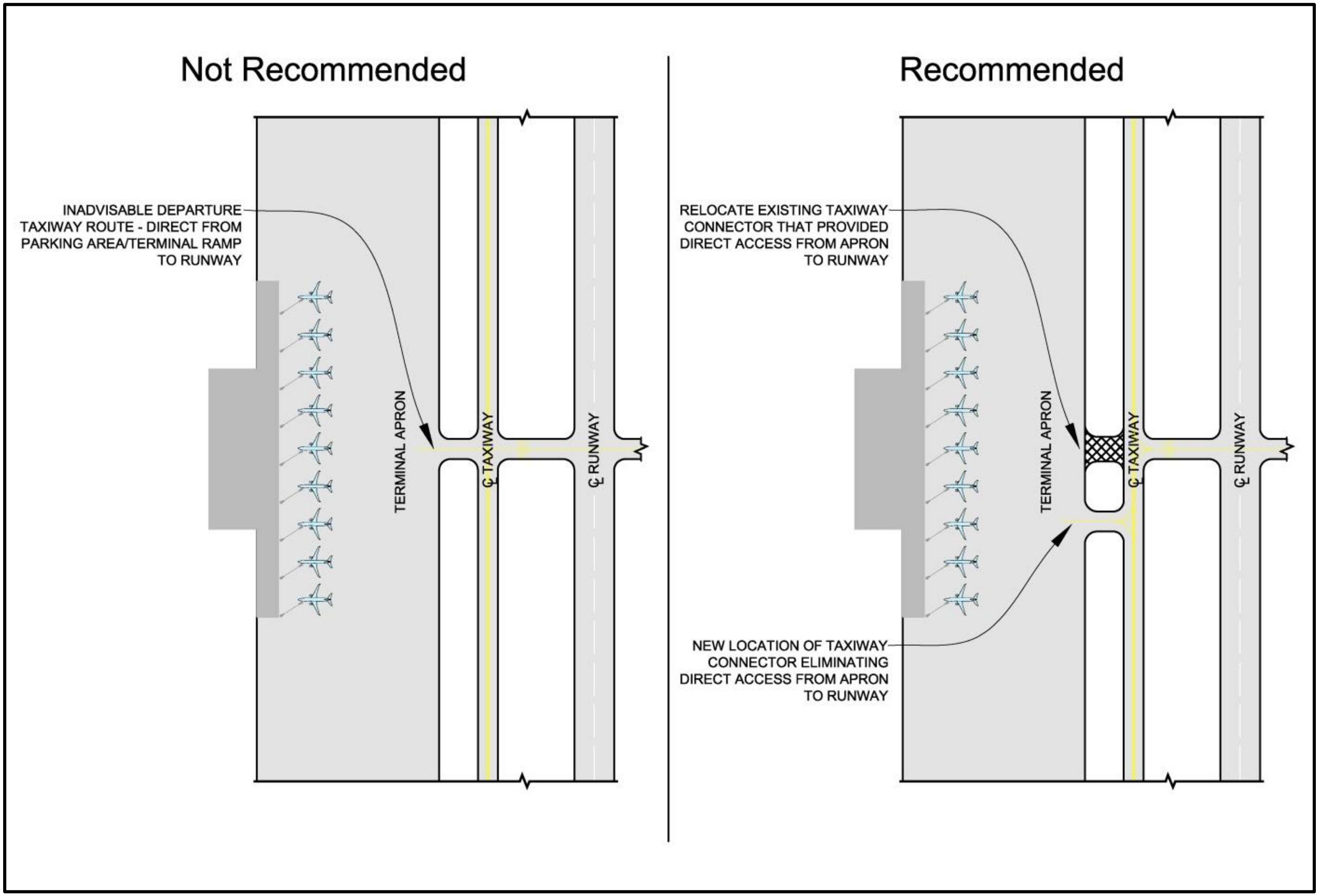
In the case of a new airport or major airport redevelopment, the determination of a new terminal site may be necessary or desirable. There are a number of basic considerations which will affect the ultimate terminal site selection:

- Runway Configuration. The runway configuration at an airport has a significant impact on the location of the apron-terminal complex. The terminal site should be located to minimize aircraft taxiing distances and active runway crossings. In general, it is most practical to locate the terminal centrally with respect to the primary runway(s). At airports with more complex runway configurations, siting may require detailed analyses to determine runway use, predominant landing and takeoff directions, location and configuration of existing taxiways, and the most efficient taxiway routings. The runway configuration may also restrict ground access to certain areas of the airport and thus limit alternative terminal sites.
- Airfield Access. Another critical consideration in the siting of terminal facilities is the layout of terminal aprons and access taxilanes or taxiways. While, minimizing taxi distances is desirable,

safety considerations are of the utmost importance. It is important to apply recommended airfield design standards to reduce the probability of runway incursions. See **Figure 5-3** for an example of proper and improper taxiway design. The example provided is per guidance in FAA AC 150/5300-13, *Airport Design*, which contains additional examples, rationale and guidance on taxiway and taxilane Design.

- FAA Geometric Design Standards and Airspace. Terminal facilities require a location which will assure adequate distances from present and future aircraft operational areas in order to satisfy FAA airport geometric design standards and remain clear of imaginary airspace surfaces. These standards include such minimum separation distances as those between a runway centerline and aircraft parking aprons, buildings, and airport property lines; and those between a taxiway centerline and fixed/movable objects and other taxiways. Refer to AC 150/5300-13, *Airport Design* for information on FAA airport geometric design standards, and 14 CFR Part 77 - Safe, Efficient Use, and Preservation Of The Navigable Airspace and United States Standard for Terminal Instrument Procedures (TERPS) for information on airport imaginary surfaces.
- Access to Highway Network. The passenger terminal should be located, when possible, to provide the most direct/shortest routing to the access transportation system (s).
- Expansion Potential. Whether the initiative is an expansion project or the development of a new terminal, the terminal layout should be developed with flexibility in mind and provide reasonable allowances for growth and changes in operation beyond forecasted needs.
- Existing and Planned Facilities. Existing and planned structures and utilities should be carefully inventoried and taken into account when planning new or expanded terminal facilities. In all cases, existing or planned locations of a FAA control tower, navigational aids, weather equipment, etc., should be analyzed to ensure that terminal development will not interfere with line-of-sight or other operational restrictions associated with these facilities.
- Terrain. Topographical conditions and the site's relation to the areas prone to flooding should be considered in the selection of a terminal building site.

Figure 5-3 Examples of Non Recommended and Recommended Taxiway Design (per AC 150/5300-13)



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CHAPTER 6. TERMINAL BUILDING SPACE PROGRAMMING

6.1 General

This chapter provides guidance on the process of terminal building space programming. Programming defines the overall terminal size as well as the size of individual terminal components necessary to meet projected activity levels. Terminal space programs can be developed for a variety of project types, ranging from high-level strategic plans to more detailed design of new or expanded facilities, with the level of detail dictated by the required outcome. Terminal building space programming is addressed following the development of the forecast and related facility requirements.

6.2 Level of Service

Level of Service (LOS) is defined as a qualitative and quantitative measurement of comfort experienced by passengers using the airport terminal facility. LOS is a key parameter to address at the onset of the spatial programming process. LOS is typically rated on a six-point scale of A through F, excellent to unacceptable, based on a number of factors. The LOS of each element of a terminal facility can vary depending on the level of crowding and/or processing time that is considered acceptable, walking distances, or other factors. A terminal should be designed to maintain a certain LOS, even during the peak periods of the day. The choice of what LOS goal to use for a facility is a balance or compromise between customer service, cost and available space. Some factors that influence LOS for terminal planning include passenger queuing space, crowding, personal space requirements related to cultural considerations, climate, target maximum queue times, average number of bags per passenger, and linear baggage claim frontage.

Guidance on LOS and accepted industry standards for LOS can be found in the following resources:

- ACRP Report 55, *Passenger Level of Service and Spatial Planning for Airport Terminals*
- ACRP Report 25, *Airport Passenger Terminal Planning and Design*
- IATA, *Airport Development Reference Manual*

6.3 Gross Terminal Area Estimates

Gross terminal area estimates are appropriate early in the planning process to determine orders of magnitude and sizing of key terminal components. Estimating generalized, gross terminal building sizes can be accomplished using the following methodologies:

- Benchmarking other terminal facilities with similar functions, passenger activity levels, and passenger demographics (e.g., a high percentage of international or connecting passengers).
- Calculating ratios based on demand and capacity (e.g., overall terminal area per required units such as gates and passengers).
- Estimating seat capacity per gate using equivalent aircraft (EQA) factors.

Guidance for the above calculations can be found in the following resources:

- ACRP Report 25, *Airport Passenger Terminal Planning and Design*
- IATA, *Airport Development Reference Manual*

6.4 **Terminal Building Space Allocation**

A planning level terminal building space program should focus on the individual functional areas and terminal components identified in Chapter 5, *Functional Relationships and Terminal Concepts*. When developing a space program it is important to consider inputs from a variety of stakeholders, including airlines and tenants, FAA, and other users. Ultimately, however, the level of stakeholder engagement is at the discretion of the airport owner/operator.

The following sections describe major functional components, key variables and necessary inputs, and industry-accepted resources to calculate space requirements. Supporting areas, such as structural or mechanical systems are also briefly discussed herein, but these areas are generally identified and planned in later phases of design.

6.4.1 Check-in Lobby

The check-in lobby is historically where departing passengers check-in for a flight, drop off checked baggage, and obtain boarding passes and other information for the flight. Traditionally, check-in lobbies were designed to be grand public spaces – the “front door” of an important public facility. Until around 2001, most check-in lobbies were long, linear spaces with large areas reserved for airline ticket counters, passenger queuing and waiting, airline ticket office space, and supporting areas such as restrooms and concessions.

Technology and evolved security requirements have significantly changed the way passengers use the check-in lobby, which has impacted space requirements. First, the advent of self-service check-in and baggage drop kiosks allows passengers to bypass the traditional check-in counters, as well as allows the check-in process to take place anywhere inside or outside the terminal building, such as the curb or parking garage. In addition, home computers and personal electronic devices allow passengers to check-in off-airport. Interactions with airline personnel are now largely reserved to drop off bags or to resolve problems. The result is a significant change in passenger and airline approaches to the check-in process and potential for reduced space requirements in the lobby. As the check-in process continues to evolve, airline processes and airport policy are likely to create more options for the traveler, some of which may result in the need for less building space allocated to the check-in lobby.

The primary components that comprise the check-in lobby are:

- Curbside check-in/baggage drop – a location outside of the terminal building, typically along the departure curbside, where passengers can perform the check-in and baggage drop function before entering the building.
- Lobby check-in/baggage drop – a location or zone inside the terminal building where passengers can perform the check-in and baggage drop function either via a self-serve kiosk or traditional airline counter; the area can be a single consolidated space or divided into segments by function (e.g., for boarding passes only or traditional check-in with an agent) or passenger classification (e.g., first class, economy, etc.); typically this area also includes airline office space.
- Passenger queuing – areas designated for passengers waiting to check in or check baggage either via self-serve kiosk or traditional airline counters.
- Public circulation – open areas from the entry vestibules to the check-in zones and from the check-in zones to the security checkpoints that allow passengers and others to efficiently move throughout the lobby, as well as vertical circulation between levels and life safety egress.

- Concessions –concessions space is warranted in the check-in lobby area to provide access to basic needs such as food and beverages and news/gifts for passengers who are delayed, may have a long pre-security wait, or are spending time with well-wishers not allowed beyond security; concessions also provide basic amenities to airport employees who do not have access to post-security areas.
- Support areas – areas allocated for support functions such as restrooms, public seating, public information kiosks, and mechanical spaces.

To develop check-in lobby space requirements, key information is required in order to make accurate assessments. Each airport and airline situation is different, but there are common variables which influence spatial requirements for the check-in lobby.

- Airport environment – are check-in lobby facilities (ticket counters or kiosks) for common use or preferential use; is there a single dominant hub airline or are there multiple airlines?
- Patrons and passengers – factors such as the ratio between originating and connecting passengers, the characteristics and requirements of passengers who check-in and drop-off baggage (e.g., elite airline passengers or passengers requiring assistance, the number of well-wishers who see passengers off, earliness arrival profiles, etc.).
- Processing rates objectives – acceptable processing rates, allowable wait times, maximum queuing lengths, etc. to meet established level of service parameters; objectives need to be balanced against facility and equipment capacities.
- Airline processes – the unique characteristics, equipment, processes, and special requirements of individual airline check-in and bag-drop policies.
- Passenger volumes – estimated passenger volumes, typically expressed in peak hour numbers, based on forecasted activity levels.

There are a wide variety of methods used to calculate space requirements depending on the level of detail required. Resources that provide in-depth explanations and tools to calculate check-in lobby space requirements include:

- ACRP Report 25, *Airport Passenger Terminal Planning and Design*
- ARCP Report 55, *Passenger Level of Service and Spatial Planning for Airport Terminals*
- ACRP Report 10, *Innovations for Airport Terminal Facilities*
- ACRP Report 23, *Airport Passenger-Related Processing Rates*
- IATA, *Airport Development Reference Manual*

6.4.2 Outbound Baggage Processing

Outbound baggage processing includes the area and equipment required to accommodate, sort, security screen, and process checked baggage from the check-in lobby to the aircraft. Outbound baggage processing includes the following main components:

- Baggage conveyance system – automated conveyor belts that sort and connect baggage from the check-in/drop-off point to the baggage security screening machines, and from the baggage screening machines to outbound baggage makeup devices.
- Primary baggage screening area – the area that accommodates screening equipment where all bags are initially inspected; cleared bags proceed to outbound baggage make-up devices and

"alarmed" bags (e.g., bags that are determined to contain suspicious contents) are either rescreened or sent to secondary screening.

- Secondary baggage screening area – the area that accommodates screening equipment where alarmed bags are manually screened a second time.
- Outbound baggage devices – automated devices that circulate and sort cleared baggage in preparation to be transported to the aircraft; these devices range from simple flat-plate run-out belts to sloped plate carousels.
- Staff support areas – area necessary to accommodate baggage screening personnel

Since the September 11, 2001 terrorist attacks and creation of the TSA, it is a federal mandate that all checked and carry-on baggage be screened. New airport terminals were built and existing terminals were substantially renovated to meet the new federal guidelines. Given differing passenger volumes and the complexity of baggage processing infrastructure, the following three variations of the screening process have been adopted:

- Stand-alone screening – used for small airports where baggage is placed into screening machines and then onto the outbound processing system by hand.
- Mini-inline systems – used at small to medium-sized airports or constrained terminals where one or multiple airlines share a single conveyor belt system that feeds a screening machine and outbound baggage device.
- Fully automated inline system – used at all other airports where multiple conveyor belts feed outbound baggage into a consolidated screening area with multiple screening machines.

The above screening processes are described in detail in TSA, *Planning Guidelines and Design Standards for Checked Baggage Inspection Systems*.

Individual airlines have different procedures to optimize their operations. Airlines should be consulted prior to design about space requirements of outbound baggage systems. To determine outbound baggage processing space requirements, an understanding of the key variables and types of input are needed. Each airport situation is different, but there are some common variables that influence space requirements for outbound baggage processing:

- System type – the type of screening process (stand-alone, mini-inline, fully automated inline) most appropriate for a given airport.
- Passenger baggage characteristics – data pertaining to the percentage of passengers checking bags, average number of bags per passenger, average traveling party size, etc.
- Processing rate objectives – acceptable conveyance system speeds, screening machines processing rates, etc. to meet established level of service parameters; objectives need to be balanced against other facility and equipment capacities, and therefore, coordination between the airport, TSA, and airlines is paramount.
- Design activity for equipment requirements – the passenger demand level that the baggage system and screening machines are designed to accommodate, and the equivalent estimated baggage demand.
- Airline processes – individual airline outbound baggage makeup processes; can be "stacked" cart staging (parked perpendicular to a baggage belt) or "linear" cart staging (parked parallel to a baggage belt).

- Passenger and baggage volumes – estimated passenger and baggage volumes, typically expressed in peak hour or numbers or bags per hour, based on forecast activity levels.

There are a range of methods to calculate space requirements depending on the level of detail required. Resources that provide in-depth explanations and tools to calculate space requirements include:

- TSA, *Planning Guidelines and Design Standards for Checked Baggage Inspection Systems*
- ACRP Report 25, *Airport Passenger Terminal Planning and Design*
- IATA, *Airport Development Reference Manual*

6.4.3 Security Screening

Security screening checkpoints are where commercial airline passengers and carry-on baggage are examined to ensure that illegal or harmful items are not carried onto aircraft. Commercial airports began to vet passengers through a security screening process beginning in the late 1960s, but it was not mandated by the FAA until 1973. However, after the September 11, 2001 terrorist attacks the Federal Government created the TSA to institute more rigorous screening procedures. Security screening procedures are complex and constantly evolving to address new threats and requirements, such as the need to screen airport employees and goods coming into the terminal building.

The primary components that comprise the security screening area are:

- Queuing area – the area reserved for passengers waiting to enter the screening area; typically segregated into multiple zones, including the main line (s) for passengers, elite airline passengers, airport employees, airline crew members.
- Document check – location where TSA employees examine a passenger's boarding pass and government issued identification to confirm authenticity and allow passengers to proceed to screening.
- Divestiture area – zone where passengers must divest items such as metal objects, electronic devices, clothing items, and baggage onto a conveyor belt to be screened; also the area where passengers wait in queue to be screened.
- Screening area – location where passengers pass through screening equipment, either via a full advanced imaging technology (AIT) or magnetometers (private, manual screening is provided remotely); baggage is screened through advanced technology machines; secondary baggage screening is located adjacent to the primary screening.
- Recomposure area – seating area or vacant space at the end of the screening checkpoint for passengers to gather and re-pack divested items.
- TSA administrative space –areas required to operate and monitor the security screening equipment located within or directly adjacent to the security screening checkpoints; space for detention rooms, training rooms, break rooms, and other administrative functions can be located remotely from the screening checkpoint.

To determine security checkpoint space requirements, an understanding of the key variables and types of input are needed. Each airport situation is different, but there are some common variables that influence security checkpoint space requirements:

- Location – where the security screening process occurs within the terminal; can be a single centralized location, or multiple checkpoints throughout the terminal(s).

- Characteristics of airline passenger, employees, and tenants – the unique attributes and special requirements of individuals going through the checkpoint such as airport employees, airline crew, elite airline passengers versus non-elite passengers who need more time/assistance, percentage of prescreened passengers, etc.
- Policy and regulations – current TSA and/or additional local guidelines and procedures.
- Processing rates objectives – acceptable processing rates, allowable wait times, maximum queuing lengths, etc. to meet established level of service parameters; objectives need to be balanced against other facility and equipment capacities.
- Passenger volumes – estimated passenger volumes, typically expressed in peak hour numbers, based on forecasted activity levels.

There are a range of methods to calculate space requirements depending on the level of detail required. Resources that provide in-depth explanations and tools to calculate space requirements include:

- TSA, *Checkpoint Design Guide*
- ACRP Report 10, *Innovations for Airport Terminal Facilities*
- ACRP Report 23, *Airport Passenger-Related Processing Rates*
- ACRP Report 25, *Airport Passenger Terminal Planning and Design*
- ACRP Report 55, *Level of Service and Spatial Planning for Airport Terminals*
- IATA, *Airport Development Reference Manual*

6.4.4 Departure Lounges / Gate Holdrooms

A departure lounge or gate holdroom is where departing passengers wait for and ultimately board flights. The following are the primary components that comprise a departure lounge:

- Waiting area – designated airline-specific space where passengers wait to board a flight. Area includes seating for passengers.
- Airline gate podium and queuing – area where passengers queue and ultimately communicate with airline representatives regarding flight information.
- Boarding and egress corridor – designated area near the gate that is used for queuing of passengers to board the aircraft, and for passenger egressing from the aircraft when it arrives at the gate; individual airlines have differing boarding and egress procedures.

Departure lounges are typically sized according to the largest aircraft able to park at the gate being served. However, not all passengers arrive and wait at the gate prior to boarding a flight. Requirements are calculated based on a percentage of total passengers who could be at the gate at a given time. In recent years, airports and airlines have been attempting to minimize capital expenditures and operating costs. Space requirements for departure lounges are increasingly being determined based on: (a) assumptions regarding flight schedules, (b) shared space among adjacent gates, and (c) the percentage of passengers who wait for flights in adjacent concession areas.

To develop departure lounge space requirements, an understanding of the key variables and types of input are needed in order to make accurate assessments. Each airport and airline situation is different, but there are common variables that influence spatial requirements for departure lounges:

- Passenger volumes or aircraft types serving the gate holdrooms – estimated passenger volumes based on forecast activity levels or passenger loads from defined aircraft types serving the gate(s).

- Airport or airline characteristics – airport policy applications (e.g., designated versus common use gates) and unique boarding processes for the airlines projected to use the departure lounges, and the physical footprint of the terminal building relative to gate location.
- Processing rates objectives – acceptable processing rates, allowable wait times, etc., to meet established level of service parameters.

There are a range of methods to calculate space requirements depending on the level of detail required.

Resources that provide in-depth explanations and tools to calculate space requirements include the following:

- ACRP Report 25, *Airport Passenger Terminal Planning and Design*
- IATA, *Airport Development Reference Manual*

6.4.5 Concessions

Airport concessions are an important component in terminal space programs. The following are primary concessions areas to be considered when developing space program requirements:

- Leased space – areas leased by the concessionaire, including: (a) the space where patrons consume food and beverages or shops for retail items, (b) food and beverage serving space or retail shelf space, and (c) close-in, "back-of-house" preparation and/or storage space.
- Duty free – retail areas exclusively reserved for departing international passengers where certain goods can be purchased exempt of local and national taxes.
- Decentralized in-terminal storage space – remote storage or food preparation areas leased by the concessionaires to serve the primary leased space; the area can be located throughout the terminal or near concessions nodes.
- Centralized remote storage space – a centralized commissary, usually away from the terminal that receives and stores incoming goods, and delivers the goods to the terminal locations on a regularly scheduled basis; the areas are typically leased and operated by a third party logistics provider.
- Parking and access – employee conveyance, access, and parking need to be considered to support concessions operations.
- Loading dock – area where deliveries of concessions goods and other deliveries are unloaded from trucks; this area can be in-terminal or at a remote location such as the "centralized remote storage area" noted above.
- Waste collection and removal – area dedicated to the collection and removal of trash, recycling, compost, etc., from tenant spaces or the collective concessions' tenant location, including back-of-house non-public circulation to support this function.

To develop concessions space requirements, an understanding of key variables is needed to make accurate calculations and assessments. Although every airport situation is unique, there are some common variables that influence the determination of space requirements:

- Passenger volumes – estimated passenger volumes based on forecast activity levels, typically expressed in annual or peak hour passengers; in general, higher passenger volumes can justify more diversity in offerings.

- Terminal geometry – the terminal layout that dictates the general flow of passengers between the check-in lobby and departure lounges; particular attention should be paid to location of the security checkpoint(s).
- Split between pre- vs. post-security – the allocation of concessions between pre-security and post-security areas, depending on the terminal layout and other airport and passenger characteristics.
- Patron types –passenger characteristics, including the numbers of business and leisure travelers, originating and connecting passengers, domestic and international passengers, etc.
- Exposure – the physical location of concessions areas, e.g., directly adjacent to the security checkpoint(s), in a centralized concession node, or in a concourse among the departure lounges.
- Concession types – the allocation of food and beverage concessions versus retail offerings including specialty retail or duty free retail.
- Centralized or decentralized storage – dependent on an airport's leasing agreements with a single or multiple concessionaires and policy regarding movement of goods through public vs. non-public areas.
- Support space allocation – amount of space required to support concession operations including back-of-house non-public circulation to support this function; can vary depending on centralized or decentralized locations.

Advertising and revenue generating signage should also be considered in the planning process in order to maximize revenue opportunities.

There are a range of methods depending on the level of detail required. Resources that provide in-depth explanations and tools to calculate concession space requirements include the following:

- ACRP Report 25, *Airport Passenger Terminal Planning and Design*
- ACRP Report 54, *Resource Manual for Airport In-Terminal Concessions*
- IATA, *Airport Development Reference Manual*

6.4.6 Baggage Claim / Inbound Baggage Processing

Baggage claim, or inbound baggage processing, includes the facilities and area required for arriving passengers to reclaim checked baggage. Baggage claim is also typically the area reserved for meeters and greeters, and where most passengers end the flight/aviation portion of their journey. Therefore, in addition to baggage claim devices and airline offices, baggage claim areas traditionally include city and transportation information, rental car counters, concessions space, and support areas such as restrooms and mechanical spaces.

Baggage claim areas are provided in both domestic and international terminals. This section is focused on domestic baggage claim, while international baggage claim is discussed under Customs and Border Protection Facilities. Baggage claim and inbound baggage processing includes the following primary components:

- Inbound baggage drop off – non-public areas where airline personnel place deplaned baggage onto conveyor belts that feed into the baggage claim devices
- Baggage claim hall – general term for the area encompassing the baggage claim devices, circulation, and other support functions, such as public seating, baggage carts, ground transportation concessionaires, customer support, etc.
- Baggage conveyance and delivery devices – devices that move and circulate deplaned passenger baggage for reclaiming.
- Baggage service office – airline office space to assist passengers with lost baggage; also an area where airlines store unclaimed bags.

To develop inbound baggage processing space requirements an understanding of key variables and types of input is needed. Some common variables which influence space requirements for inbound baggage processing are:

- Baggage claim device type – flat plate or sloped plate devices; the latter has more baggage handling capacity and requires fewer carousels.
- Baggage claim device usage/allocation – airline claim for device usage (e.g., preferential versus common use); the latter is more efficient because of sharing between airlines.
- Passenger baggage characteristics – the percentage of passengers checking bags, average number of bags per passenger, and average traveling party size.
- Processing rates objectives – acceptable conveyance system and claim device speeds, allowable wait times, etc. to meet established level of service parameters; objectives need to be balanced against other facility and equipment capacities.
- Design activity for equipment requirements – a year linked to a passenger demand level that the baggage system and machines are designed to accommodate.

- Passenger and baggage volumes – estimated passenger and baggage volumes, typically expressed in peak period or numbers of bags per hour, based on forecast activity levels.

There are a range of methods to calculate space requirements depending on the level of detail required. Resources that provide in-depth explanations and tools to calculate space requirements include:

- ACRP Report 10, *Innovations for Airport Terminal Facilities*
- ACRP Report 25, *Airport Passenger Terminal Planning and Design*

6.4.7 Customs and Border Protection Facilities

The U.S. CBP operates Federal Inspection Stations (FIS), where arriving international passengers and their baggage are inspected to allow clearance into the United States. These facilities are commonly referred to as FIS facilities, and are only located in terminals that serve arriving international passengers. It is a sterile area and physically separated from arriving domestic passengers.

The primary components of an FIS are:

- Sterile corridor – circulation area used by arriving international passengers that connects the PBB to the FIS facility; the area is separated from the sterile public area of the terminal where passengers on domestic flights enplane and deplane.
- Primary processing – a first inspection point where federal representatives authenticate the identity of arriving international passengers; the area is split into two queuing and processing zones, one for United States citizens and one for foreign nationals.
- Baggage claim – area where arriving international passengers reclaim checked baggage.
- Recheck facilities – check-in area adjacent to the FIS facilities where arriving international passengers can check-in or drop-off bag(s) for connecting domestic flights.
- Secondary processing – additional inspection point at the exit of the baggage claim for issues that arise with passports/visas, baggage inspections, or interview and personal searches.
- Administrative areas – space for CBP administrative functions including offices, monitoring rooms, interrogation rooms, private inspection rooms, equipment storage areas, waste or contraband disposal rooms, quarantine facilities, etc.
- Public area – reserved area located at the exit of the FIS facility for meeters and greeters.

CBP classifies airports into the following four categories:

- Small airports – less than 800 arriving international passengers per hour.
- Low volume mid-size airports – 800 to 1,400 arriving international passengers per hour.
- High volume mid-size airports – 1,400 to 2,000 arriving international passengers per hour.
- Large airports – 2,000 or more arriving international passengers per hour.

This classification is a key variable in determining space requirements because passenger volumes determine staffing priorities. At smaller airports, not all functions may be needed, which can reduce the space program. In some cases, airports may implement a “swing gate” whereby the gate may be used for domestic or international arrivals by alternating the separation component. Airport operators should be proactive with CBP involvement when planning international arrivals facilities. The process that an airport operator should follow from planning through design and construction is delineated in U.S. CBP, *Airport Technical Design Standards, Passenger Processing Facilitie*s.

To develop CBP space requirements, an understanding of key variables and types of input is needed. Each airport situation is different, but some common variables which influence CBP spatial requirements are:

- Volume of and type of international aircraft arrivals and volume of passengers – estimated passenger volumes based on forecast activity levels, typically expressed in the number of peak hour passengers.
- Processing rates objectives – acceptable processing rates, allowable wait times, queuing lengths, etc., to meet established level of service parameters.
- Airline passenger characteristics – the characteristics of passengers processed through the FIS facility, including number of bags per passenger, percentage of foreign nationals, traveling party size, etc.
- Administrative and operational program requirement inputs from CBP.
- Connection to airports with use of preclearance facilities.

Additional resources that provide in-depth explanations and tools to calculate space requirements include:

- U.S. CBP, Airport Technical Design Standards, Passenger Processing Facilities
- ACRP Report 25, *Airport Passenger Terminal Planning and Design*
- ACRP Report 10, *Innovations for Airport Terminal Facilities*

6.4.8 Restrooms

A space program for terminal restrooms must be developed per local building code and Americans with Disabilities Act (ADA) standards. Additionally, there are number of airport-specific variables that should also be considered:

- Passenger volumes – estimates of passenger volumes in specific terminal areas based on forecast activity levels, fleet mix, arrival/departure frequency, typically expressed in the number of peak hour or peak period passengers.
- Airport-specific passenger processing and layout – understanding airport specific variables that define restroom catchment zones, such as the location of the security screening area, concessions areas, and amount of space dedicated to departure lounges, etc.
- Sizing of restrooms and layout – programming adequate space to accommodate ambulatory travelers and travelers with disabilities (wheelchair-accessible) that have luggage. Consider out-swinging stall doors, open restroom entryways without doors, touch-free restroom environments, etc.
- Male vs. female allocation – understanding the balance of demand for male and female restrooms and number and types of bathroom fixtures.
- Related restroom facilities – companion and family restrooms, nursing stations separate from restrooms, baby diaper changing areas, and service animal relief areas (SARA).

For more information on the topic, see the following:

- *ADA Standards for Accessible Design*

- ACRP Report 130, *Guidebook for Airport Terminal Restroom Planning and Design*
- ACRP Report 25, *Airport Passenger Terminal Planning and Design, Volume 1: Guidebook*
- ACRP Synthesis Report 64, Issues Related to Accommodating Animals Traveling Through Airports
- AC 150/5360-14, *Access to Airports by Individuals with Disabilities*

6.4.9 Tenant and Airport Operations

Airline, tenant, and airport operations areas are leased areas that support the operations and management of tenants. In recent years, these entities have been reducing, consolidating, or eliminating these areas to reduce operating costs. However, some areas are still required, including: (a) office space for management personnel, (b) flight crew facilities, such as lounge/rest areas, and (c) storage, and other support areas. Airline-specific input is needed to accurately define and locate airline operations space.

Airport operations and administration space is office space reserved for general airport management and operations, emergency response, staff medical facilities, security offices, airport police, and other similar functions. Other airport tenants such as concessionaires and the TSA may also lease similar space depending on airport policy and facility layout. Input from airport management and other operators or tenants or private clubroom operators who might use such space is necessary in developing space requirements.

Airline clubrooms are tenant spaces provided by airlines to cater to their frequent and elite travelers. Typically, clubrooms are found at hub airports or at an airport with a large passenger volume or high-yield passengers. At international airports, global airline alliances provide common use clubs for all premium passengers within their alliance. Recently, some airports have been developing premium lounges, sponsored and operated by a 3rd party, to cater to premium passengers who are not associated with an alliance, but still want the experience. It is strongly recommended that airport operators engage airline tenants to determine clubroom requirements, which can vary significantly.

6.4.10 Public Amenities

Public amenities are additional areas within the terminal building that facilitate passenger convenience and facilitate level of service objectives. These areas may include the following:

- Information centers – locations where passengers can ask questions about the airport or the local environs; these tend to be booths or kiosks in the baggage claim or check-in lobby.
- Computer and phone recharging stations – areas where passengers can recharge electronic devices; such stations can be provided by the airport or a third-party operator and are typically located near departure lounges.
- United Service Organizations (USO) facilities for armed services personnel.
- Passenger sanctuaries – non-denominational or interfaith areas within the terminal complex for worship, meditation, or to offer passengers refuge.
- Smoking facilities – contained indoor and sometimes outdoor areas for smoking.
- Wheelchair storage – area where airport staff can store wheelchairs used for escorting passengers who need assistance in the terminal.
- Luggage carts – storage area for luggage carts usually in the check-in or baggage claim hall, generally provided by a third-party operator.

The above are common to all airports; however, the size and location should be determined on a case-by-case basis and varies depending on terminal and environmental characteristics. Another resource to define space requirements for public amenities is ACRP Report 25, *Airport Passenger Terminal Planning and Design*.

6.4.11 Building Services

A portion of all terminal buildings is allocated to space is required for building operations and equipment. Examples include:

- Maintenance and storage – areas allocated to airport maintenance staff and storage of maintenance equipment.
- Operations – space allocated to general airport operations, emergency response, staff medical facilities, security offices, and other similar functions.
- Mechanical system rooms– areas allocated to heating ventilation and air conditioning (HVAC) systems and other infrastructure needed for the building to operate.
- Utilities – areas allocated to operate or provide access to major airport utilities, which can include electrical, technology related infrastructure, communications equipment, plumbing and many more systems needed for the building to operate.
- Structural systems – areas allocated to the structural support of the building; usually 5% of the terminal's total gross area.
- Life safety egress – facilities allowing for the exit or evacuation of passengers in the terminal building during an emergency.

The above areas are unique to each airport and should be calculated on a case-by-case basis. See ACRP Report 25, *Airport Passenger Terminal Planning and Design* for information on defining building services spatial requirements.

6.4.12 Signage and Wayfinding

Signage and wayfinding is an important airport terminal component that facilitates the movement of departing passengers from the airport access roadway (or transit system) through the terminal to the departure lounge; and vice-versa for arriving passengers. However, passenger demographics are diverse, and can include frequent business travelers, first time travelers, international passengers, aging passengers and passengers with disabilities. Therefore, it is important that signage and wayfinding is consistent and reliable throughout the airport, and meets all local and national code compliance standards.

The following are factors to consider when developing a signage and wayfinding program:

- Graphic standards – a uniform visual theme that complies with industry, international standards and local code is important and should be consistent in appearance, concept, and location; carefully considering font type, font size, character spacing, and signage illumination for a wide range of users. Note that it is good practice for temporary and tenant branded signage to be consistent with airport graphic standards.
- Terminology – consistent and easy to understand wording is important.
- Spacing – a consistent frequency of signage and placement is a value, considering building design and passenger flows.

- Maintenance and fabrication – materials and site locations should optimize signage maintenance.
- Code compliance – program should accommodate all special requirements, such as ADA Standards for Accessible design and local building codes.

As a result of technology advances, signage and wayfinding have become more flexible, focused, and passenger friendly. Signage that used to be static can now be dynamic, meaning that messages displayed can change depending on requirements. For example, security checkpoint wait times can be displayed at a central terminal location to inform passengers of the location of the fastest checkpoints. In addition, mobile technology such as smart phones and tablets provide passengers accessible indoor maps and the capability to navigate through the entire airport. Such technology will continue to evolve as a component of the terminal environment. Airport operators should consider and incorporate new technology into the terminal program at the planning stage to maintain maximum flexibility and adapt to changing needs.

ACRP Report 52, *Wayfinding and Signage Guidelines for Airport Terminals and Landside* provides detailed explanations and best practices for developing signage and wayfinding programs. For specific information on airport landside considerations for signage and wayfinding, see Section 8.8, Landside Signage and Wayfinding.

6.4.13 Security Area Delineation and Control Systems

There are three distinct security zones within the terminal: public areas for passengers and non-passengers, sterile areas for screened passengers, and secure non-public areas for airport and airline employees. There are numerous FAA, TSA, local law enforcement regulation definitions, and equally as many site specific regulations for airports.

Security areas include:

- Public area – the non-sterile area that is open to the general public, commonly referred to as "pre-security".
- Sterile area – public area for passengers who have been screened by the TSA, commonly referred to as "post-security".
- Secured area – the areas located outside the terminal or concourse where only approved airport or airline employees are permitted (e.g., the aircraft parking apron).
- Security Identification Display Area (SIDA) – designated areas where only approved airport of airline employees, contractors, concession employees, FAA personnel and others are permitted (e.g., "back-of-house" concessions circulation corridors).
- FIS sterile area – controlled area for arriving international passengers before they have been cleared by CBP to enter the country (e.g., "sterile" corridors that connects the aircraft boarding gate to the FIS facility).

These areas have a variety of control systems to ensure the security of the terminal, including access controls and video surveillance. A key source of information on this topic is the TSA-developed document, *Recommended Security Guidelines for Airport Planning, Design and Construction*. Additionally, an industry-recognized publication that provides extensive guidance is the *Integrated Security System Standards for Airport Access Control* (Radio Technical Commission for Aeronautics).

6.5 Trends and Innovations

Terminal planning and design followed industry-accepted processes and general layouts for many decades. Major events and developments that occurred around the turn of the century – such as the September 11, 2001 terrorist attacks and technological advances (e.g., mobile devices, self-service kiosks, etc.) – have significantly changed how airports and airlines operate. These events, and the impact of changing passenger demographics, continue to impact the evolution of the terminal building as well as terminal planning and space programing.

6.5.1 Flexible Space Planning

Given the evolution in terminal building spatial and functional needs, it is increasingly important to build facilities that can adapt over time. Flexible layouts are important to consider, as is the design of interior spaces. The concept of “programmable design” is one that has gained traction because it allows for interior functional components to be moved around and adapted to new passenger flows driven by technology or other innovations. Column-free space is one aspect that makes programmable space work. Another technique that helps owners adapt their buildings to changing needs is the location of certain mechanical infrastructure such as electrical and telecommunications elements that can be plugged into at locations throughout the building. The use of prefabricated, modular building elements can also be used to create systems that can be reconfigured and adapted to work as functions change.

6.5.2 Passenger Demographics

Airline passenger profiles are diverse, ranging from frequent business travelers to leisure or first-time travelers. In the past decade, the focus of the industry has shifted to frequent travelers who have an interest in self-service and use “smart” devices to facilitate the passenger processing experience. However, there are numerous other demographics that should be considered, including:

- Aging population – an increasing aging population will require more space for such functions as vertical circulation, wayfinding, long walking distances, etc.; ACRP Synthesis Report 51, *Impact of Aging Travelers on Airports* provides an in-depth explanation and best practices for addressing this aspect of changing demographics.
- Non-tech savvy passengers – not all passengers will adapt to self-service or mobile technologies. A portion of the traveling public will continue to require traditional face-to-face assistance in the airport terminal.
- Language diversity – a growing number of domestic and international passengers require information to be available in multiple languages. The extent of language diversity varies geographically.

6.5.3 Self-service Processing

Airline passengers have come to expect that they will be able to receive help or process themselves with the assistance of technology in a variety of industries (e.g., banks, gas stations, grocery stores, video kiosks, etc.). This trend is being embraced in the airport environment with self-service kiosks and remote processing technologies, which enables passengers to check themselves in for a flight. Locating these devices outside the terminal building in parking garages, rental car return facilities, and intermodal transportation centers allows passengers to bypass the ticket counter entirely and proceed directly to security screening. Self-service processing can even begin through the Internet before they arrive at the airport. Using other innovations, passengers are able to buy tickets on the internet, check-in for a flight with smart devices, print baggage tags, and even purchase meals that will be ready when they arrive.

The impact of self-service is freeing up traditional check-in lobby space for alternative uses. Inside the concourse, passengers can navigate to preferred concessions and departure lounge locations using smart phone applications, reducing the reliance on signage and wayfinding. Self-boarding is taking place at some international airports, and is being tested at some facilities in the United States. Automated Passport Control is a U.S. CBP program that expedites the entry process for United States, Canadian and eligible Visa Waiver Program international travelers by providing an automated process through CBP's Primary Inspection area. Travelers use self-service kiosks or via mobile application to submit their Customs declaration form and biographic information. Travelers using this program experience shorter wait times, less congestion, and faster processing.

6.5.4 Passenger Experience

Enhanced passenger security screening and other factors can contribute to an unpleasant passenger experience in some airport terminals. Hence, there has been a renewed effort by airport operators to provide a more positive passenger experience via some of the technological and self-serve advances noted above as well as through architectural design and other customer service improvements. Examples of these innovations are:

- Open lounge waiting areas – traditional departure lounges are being replaced by large open, light-filled spaces with Wi-Fi connectivity, big-screen televisions, comfortable lounge seating, easily accessible power connections, and concessions, which together provide a place of comfort and relaxation for all classes of passengers.
- Improved restroom facilities – one of the first and last things that passengers experience at airports are the restroom facilities and often represent one of the most significant sources of customer complaints. Improving restrooms to meet current passenger expectations is a high priority for many airports.
- Performances and events – such activities can provide a sense of place and allows the airport to become a marketing tool for local tourism. Examples include free live music or theme events during the busiest travel periods, such as sidewalk sales and local product and food sampling.
- Spa facilities and health clinics – to ease the burden of long layovers, some airports are implementing one-stop-shops for all things relaxing—massages, spa, sauna, and even fitness facilities. Other offerings include pharmacies and walk-in health clinics, which capture a sizable portion of passengers and employees who want access to basic health care such as the need to fill prescriptions while traveling.
- Art and culture– some airports are offering in-terminal art or cultural museums to enhance the airport experience.

6.5.5 Cost Reduction and Revenue Enhancement

Self-service processing and a renewed emphasis on the passenger experience are positive developments for the passenger, but they also benefit the airline operators. The 2008 financial crisis combined with rising fuel costs forced the airlines to seek cost reduction measures. Airlines turned to consolidation as one way to reduce costs, but they have also taken advantage of the same technologies that passengers are using to reduce costs. Recent and projected increases in self-service processing will lower airline staffing requirements. Reductions in staffing will reduce the space program for major functional elements and for back-of-house office space, thereby reducing capital expenditures for airport operators.

Airports have also increased their emphasis on improving operations, reducing cost, and enhancing revenue generation. The most effective way to improve revenue is to improve or increase concessions in the terminal. In conjunction with self-service processing and enhanced passenger experiences, airports are increasing the impact and size of concessions programs. This can include:

- Relocating concessions from pre-security to post security areas, and to locations where there is a high volume of passenger traffic.
- Improving concessions quality by making local and high quality goods available.
- Adding other “experiences” like music, etc., as noted in the section above. Other ways to improve financial performance are to improve terminal building operations and the efficiency of terminal building mechanical, electrical, and plumbing systems by upgrading infrastructure.

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CHAPTER 7. TERMINAL APRON AREAS

7.1 General

This chapter describes key terminal apron elements and general guidelines for planning terminal apron areas.

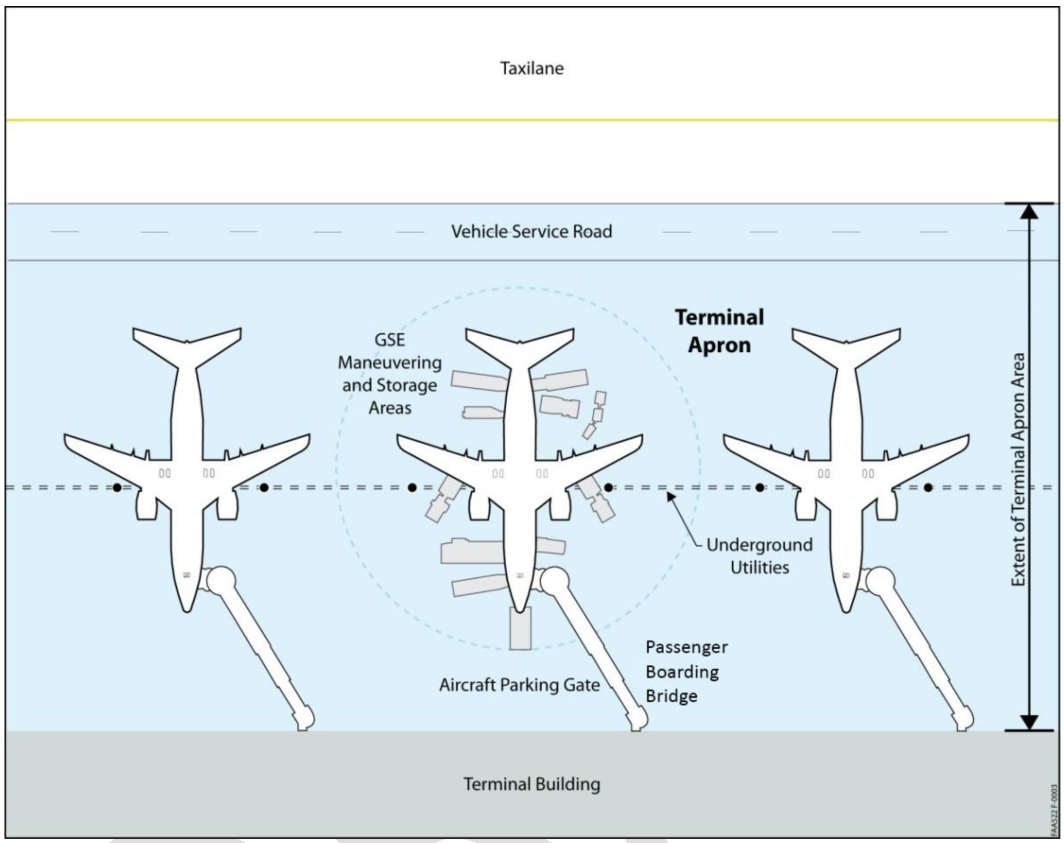
Planning these areas can occur at various stages, e.g.; for a new facility when the terminal building layouts and geometry are being drawn at a conceptual level, for an existing facility where the fleet mix has changed or during the planning of a terminal expansion, etc.

The terminal apron area is the portion of pavement between the face of the terminal building and the movement area. The primary functions of the apron area are to: (a) provide a safe and efficient space for aircraft to maneuver from the airfield to the terminal building, (b) optimize aircraft parking flexibility and interaction with the terminal, and (c) accommodate maneuvering and staging of GSE for aircraft servicing. Key elements of the apron area are:

- Apron pavement – surface area designed to provide a firm, stable, smooth, all-year, all-weather surface, adequate to support the design aircraft. See AC 5320-6, *Airport Pavement Design and Evaluation* for guidance on airport pavement design.
- Aircraft parking gate – pavement area for aircraft parking; examples include contact gates with loading bridges, ground loaded, remote, and RON positions.
- Passenger Boarding Bridge – enclosed structure that allows for the movement of passengers, in a controlled environment, to transition between the concourse and the aircraft; normally contains power and cooling systems that service the aircraft while parked at the gate.
- GSE maneuvering and storage areas – apron area adjacent to the aircraft parking position that is used for maneuvering and parking aircraft servicing vehicles such as baggage tugs, fueling trucks, catering trucks, and maintenance equipment.
- Vehicle service roads – marked pavement areas that provide GSE access to move about the apron or circulate around aircraft; typically two-way roads that are 20 to 25 feet wide.
- Taxilanes – A taxiway designed for low speed and precise taxiing. Taxilanes are usually, but not always, located outside the movement area, providing access from taxiways to aircraft parking positions, other terminal areas, and other connector taxiways.
- Utilities –infrastructure that allows servicing of aircraft while parked at an aircraft parking gate; examples include hydrant fueling, apron lighting, grounding systems, conditioned air and power, stormwater, deicing, and fire deluge systems.

A generalized depiction of the terminal apron area is presented in **Figure 7-1**. The optimum apron design for a specific airport will depend upon available space, aircraft fleet mix, and terminal building configuration.

Figure 7-1 TERMINAL APRON AREA



7.2 Aircraft Parking Gates

There are four types of aircraft parking gates: contact gates, ground loaded, remote, and RON positions. An airport operator's choice between the various gate types depends on passenger level-of-service objectives, aircraft fleet and operations, and the characteristics of the concourse geometry or other physical constraints. The following provides a description of each gate type.

7.2.1 <u>Contact Gates</u>

A contact gate is an aircraft parking position that is connected directly to the concourse via a PBB. Contact gates are the most common type of gate in the United States, and provide the highest level of passenger service primarily because of the short distance between the holdroom and the aircraft, and the controlled environment of the PBB. In certain constrained concourse geometries or uniquely shaped terminal apron areas, a loading bridge is attached to a fixed bridge extension.

7.2.2 Ground Loaded and Remote Gates

Ground loaded gates are located adjacent to the concourse, but the transition of passengers between the concourse and aircraft is via the apron pavement instead of a PBB. In typical ground loaded operations, passengers wait to board the aircraft from a holdroom and then access the aircraft through a covered walkway and stairs up to the aircraft. In the United States, ground loading is typically reserved for smaller capacity aircraft and/or aircraft with low door heights that do not work well with traditional PBBs, such as regional jets or turbo-prop aircraft. Compared to contact gates, ground loading is considered a lower level of passenger service because of longer walking distances, the need to climb stairs (normally with carry-on luggage), and exposure to weather.

Remote gates are the same as ground loaded gates, but the gate is physically located remote from the concourse, and therefore, busses are required to transition passengers between the concourse and the aircraft. Remote gates represent a low cost alternative to construction of additional concourse infrastructure; and are often used in situations where passenger demand greatly exceeds terminal capacity or when rear deplaning of passengers is needed.

7.2.3 Remain Overnight Positions

RON positions are used for parking non-active aircraft away from the terminal, thereby freeing up contact or other gates for passenger operations. In the U.S, RON positions are commonly used for the overnight parking of aircraft not scheduled to depart until the next day. RON positions are essential at international airports where aircraft typically remain on the ground for longer periods of time, or at airports with heavy, frequent service peaks.

7.3 Aircraft Parking Gate Requirements

The number of aircraft parking gates required (in addition to their size) are a key element that define terminal building geometry and linear building requirements. There are various methods to calculate gate requirements depending on the level of detail required. At the master plan level, either annual gate utilization or peak hour utilization in combination with aircraft type are used to determine gate requirements. At a more detailed design level, peak hour utilization is necessary.

Annual gate utilization is calculated by dividing the total number of annual average day aircraft departures by the total number of aircraft parking gates (number of turns per day at a gate). Future gate requirements are determined by applying this ratio (and/or adjusting it up or down) to forecast annual average day aircraft operations.

As described in Chapter 4*, Planning and Design Methodologies and Tools*, peak hour utilization and resulting gate requirements can be determined through the development of a future “design day” flight schedule based on forecast growth. A design day flight schedule provides a distribution of flights and passengers on an hourly basis throughout the design day. The peak hour is identified as the hour in the schedule that includes the highest volumes of activity. Future peak hour volumes are determined by applying appropriate growth rates to the existing design day flight schedule and increasing activity levels to meet forecast demand. This is accomplished via a combination of “up-gauging” aircraft types (utilizing larger aircraft with higher numbers of seats per plane) and the introduction of additional flights (depending on the strategies most likely to be deployed by the airlines at the airport). Other operational factors like common use versus preferential use gates should be considered when determining peak hour gate requirements.

In addition, irregular operations due to bad weather, special events, or emergency situations should also be considered in determining gate requirements. Although infrequent, such events may result in unusual demand for gates and congestion on the terminal apron. Strategies for accommodating irregular operations include provisions for ground loading passengers onto aircraft at remote gates or implementing common use contact or ground loaded gates.

Detailed explanations of methodologies used to determine gate requirements can be found in:

- ACRP Report 23, *Airport Passenger-Related Processing Rates*
- ACRP Report 25, *Airport Passenger Terminal Planning and Design*

7.3.1 Aircraft Parking Gate Layouts

The layout of aircraft parking positions is an extremely important element that requires careful consideration during related terminal planning and design efforts. Aircraft parking position layouts can vary significantly depending on airport or airline practices, tenant and airline lease negotiations and such variances can impact many other requirements throughout the terminal facility. Basic criteria associated with parking position layouts are described below and illustrated in **Figure 7-2**.

- Gate width – The width of the aircraft parking position envelope. It is one of the most critical factors, which influences the linear length of the terminal or concourse. There are three main approaches to determining the width of a gate or gates: by Airplane Design Group (ADG), by the most critical aircraft, or by grouping of critical aircraft. To ensure proper planning, the choice of aircraft, equipment specifics, and accurate aircraft dimensions must be determined with care. It is recommended that the aircraft type (s) and configuration (e.g. with or without winglets) used to size a gate is carefully coordinated and validated with all stakeholders using dimensions from the aircraft manufacturers to ensure adequate space is allocated.
- Wingtip Clearance – The distance between an aircraft wingtip to adjacent parked aircraft wingtip or building façade. Adequate clearance between and around aircraft wingtips is necessary to allow safe and efficient movement of aircraft to and from aircraft parking positions, to prevent collision of maneuvering aircraft, to allow adequate GSE access and maneuverability and to allow unobstructed access for emergency response vehicles (e.g., Aircraft Rescue and Fire Fighting, emergency medical responders, and airport police). The industry-accepted distance for wingtip clearance dimensions to be used in planning or design of aircraft parking positions (for commercial service aircraft) are: 25-feet from one aircraft to another parked aircraft and 45-feet for inboard pier gates from the wingtip to the adjacent building façade. See **Figure 7-2** for a graphical depiction. It should be noted that the actual dimensions used by airlines can vary depending on their policies and operational preferences.
- Nose to building clearance – distance from the nose of the aircraft to the concourse for pushback tug maneuvering and other safety requirements. The distance can also be driven by the required length of the PBB to meet ADA slop requirements for the design aircraft.
- Gate depth – distance from the face of the concourse to the edge of the vehicle service roads or taxiway/taxilane object free area for parking aircraft. The depth of the gate is determined primarily by the length of the largest aircraft projected to be accommodated at the position and the nose to building clearance.
- GSE parking and storage area– marked locations on the apron where GSE such as fueling trucks, baggage tugs, and other aircraft servicing equipment service the aircraft or are stored.

- Vehicle service roadways – designated roadways for service vehicles to maneuver safely on and around the apron area; can be located behind the aircraft's tail (back of stand), in front of the aircraft nose (head of stand), between wingtips or can be routed beneath the concourse. The limits of vehicle service roadways should be clearly marked to ensure lateral and vertical clearance are maintained between parked aircraft and vehicles traversing the service roads.
- Airport traffic control tower and ramp control tower line-of-sight – it is critical to ensure that visibility from the ATCT cab is not compromised as a result of facility development. An unobstructed view of all controlled movement areas is required, including all runways, taxiways, and any other landing areas, and air traffic in the vicinity of the airport. See AC 150/5300-13, *Airport Design* and Order 6480.4, *Airport Traffic Control Tower Siting Process* for additional information.
- Airport imaginary surfaces and airport design surfaces - must be carefully considered during facility development to ensure compatibility with existing and planned airport configurations. See AC 150/5300-13, *Airport Design*, 14 CFR Part 77 and Order 8260.3, *United States Standard for Terminal Instrument Procedures (TERPS* for information on airport imaginary surfaces and airport design surfaces.
- Jet blast – considerations for jet blast are a critical design factor on aircraft parking aprons. This is critical to consider in order to protect passengers, operations staff, adjacent aircraft, airport facilities, etc. For guidance on the effects and treatment of jet blast and criteria for design and layout, see AC 150/5300-13, *Airport Design.*
- Utilities – The location of utilities is also a critical consideration when laying out or reconfiguring aircraft parking.

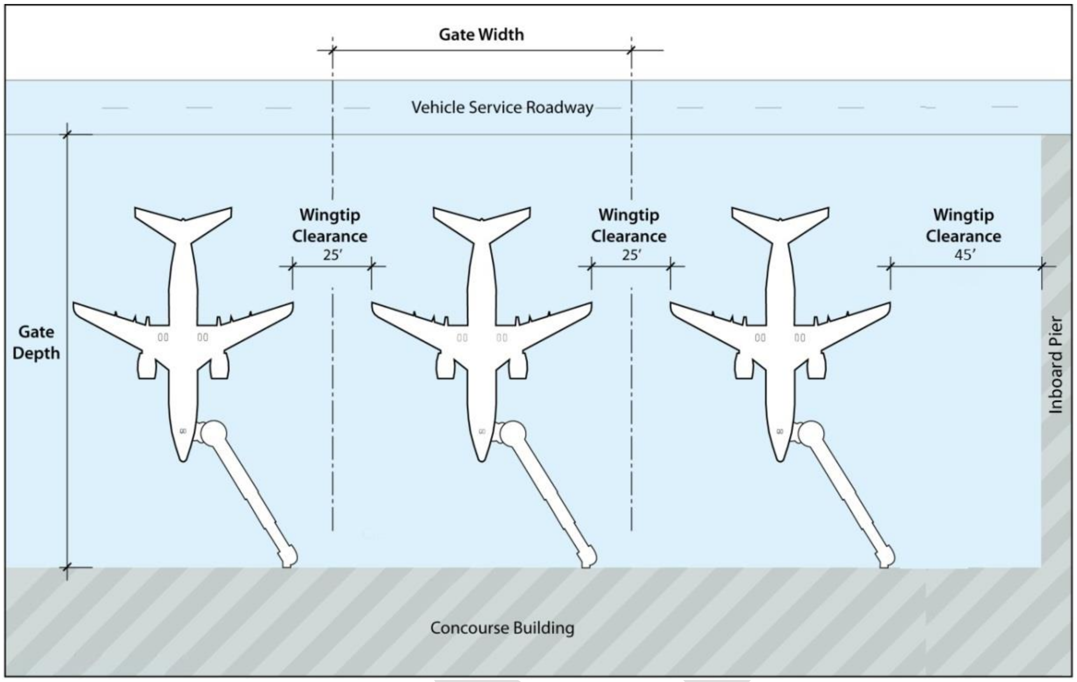
Detailed information regarding the layout of aircraft parking positions, apron design and related considerations can be found in:

- FAA AC 150/5300-13, *Airport Design*
- Order 6480.4, *Airport Traffic Control Tower Siting Process*
- 14 CFR Part 77 - Safe, Efficient Use, and Preservation Of The Navigable Airspace
- ACRP Report 25, *Airport Passenger Terminal Planning and Design, Volume 1*
- ACRP Report 96, *Apron Planning and Design Guidebook*
- FAA Order 8260.3, *United States Standard for Terminal Instrument Procedures (TERPS)*
- FAA AC 150/5340-1, *Standards for Airport Markings*
- Airports Council International (ACI), *Apron Markings and Signs Handbook*
- FAA AC 5320-6, *Airport Pavement Design and Evaluation*

7.3.2 Aircraft Parking Gate Operations

The most common type of aircraft parking operation at United States airports is where aircraft taxi under engine power into the gate parking position, but are pushed back from the gate via a ground tug (taxi-in/push-back) before accessing the taxilane. Power-out operations, in which an aircraft leaves the gate position using its own power via either reverse engine thrust or forward movement, are much less common and normally acceptable at smaller, less congested airports. In addition, advanced docking systems are automated systems that can precisely guide aircraft to the aircraft parking position stop bars, as well as dock the PBB to the aircraft.

Figure 7-2 Aircraft Parking Gate Layout



7.3.3 Boarding Bridges and Fixed Utilities

The two most common PBBs are “fixed” and “apron drive.” Fixed PBBs are connected directly to the concourse or to a fixed bridge extension. They are limited in flexibility (e.g., not able to rotate on a pedestal) and can only expand and contract from a single point. Apron drive PBBs can expand and contract like a fixed PBB but also rotate or move about from a static pedestal. Apron drive PBBs provide maximum flexibility, which is desirable since aircraft types and other procedures often change.

Aircraft fleet mix is a key factor in determining the number, location, and position of PBBs. Passenger flow volumes associated with a single aisle, narrowbody aircraft (e.g., ADG-III or B757) can typically be accommodated by a single PBB. Twin aisle, wide body aircraft (e.g., ADG-IV and larger) have greater passenger flow volumes due to the number of seats and egress doors.

PBBs should be positioned to maintain maximum flexibility to accommodate as many aircraft types as possible. If there are two loading bridges at the same gate, they should be designed to accommodate loading for both a large widebody aircraft and two narrowbody or smaller aircraft. PBBs should also be located so that the slope of the bridge(s) is no greater than 12:1 for the gate’s intended aircraft mix, to meet ADA requirements.

PBBs and adjacent terminal apron areas contain many utilities that service an aircraft at a gate, including ground power, conditioned air, potable water, and aircraft fueling. There are a number of industry recognized publications that provide a detailed explanation of these utilities and planning considerations associated with them. Comprehensive passenger boarding bridge and utility standards and requirements can be found in the following industry recognized publications:

- FAA AC 150/5220-21C, *Aircraft Boarding Equipment*
- FAA AC 150/5300-13, *Airport Design*

- ACRP Report 25, *Airport Passenger Terminal Planning and Design*
- ACRP Report 96, *Apron Planning and Design Guidebook*

National fire code regulations related to the apron area can be found in the National Fire Protection Association (NFPA) 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways* (Note: please review other related NFPA codes and standards which may also be applicable) , and ADA compliance requirements can be found in *2010 ADA Standards for Accessible Design*. AC 150/5360-14, *Access to Airports by Individuals with Disabilities* provides additional information to assist airports in complying with the current laws and regulations regarding individuals with disabilities.

7.4 Taxilanes and Aprons

Taxilanes are paved areas designed for low speed and precise taxiing. Taxilanes are usually, but not always, located outside the movement area, providing access from taxiways (usually an apron taxiway) to aircraft parking positions and other terminal areas. Both single and multiple taxilanes should be considered for aircraft to maneuver around a concourse, parked aircraft, vehicles, etc. For drainage requirements, fire protection, and ease of aircraft movements apron gradients should meet recommended design criteria in AC 150/5300-13, *Airport Design* and always slope away from the concourse and fixed loading bridges.

A comprehensive explanation of the principles and design standards for taxilanes and aprons can be found in:

- FAA AC 150/5300-13, *Airport Design*
- ACRP Report 96, *Apron Planning and Design Guidebook*

7.5 Apron Lighting

Most outdoor areas associated with the terminal apron require some degree of illumination during nighttime and low-visibility conditions. Lighting levels in the vicinity of aircraft parking areas and the terminal apron should be of sufficient intensity to provide a safe, secure and efficient operating environment for typical airport operations during normal nighttime conditions and during inclement weather (e.g. to permit deicing at the gate).

Mounted floodlights are the usual preferred method of lighting the apron area. Floodlights should be sited, aimed and shielded to avoid glint and glare to pilots and air traffic controllers without reducing the level of illumination in critical areas. Additionally, to enhance visibility it is preferable to have uniform illumination across lighted areas using multiple overlapping light sources from different directions to minimize strong ground shadowing. Coordinate with airport operators (e.g., airline management and ground service providers) when designing or modifying apron lighting systems.

For additional information on the topic of apron lighting see the following:

- AC 150/5300-14C - Design of Aircraft Deicing Facilities. The document includes a section specifically on lighting requirements for aircraft deicing facilities.
- ACRP Report 25, *Airport Passenger Terminal Planning and Design*
- Illuminating Engineering Society (IES), Outdoor Lighting for Airport Environments (RP-37-15)

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CHAPTER 8. AIRPORT GROUND ACCESS AND CIRCULATION

8.1 General

This chapter provides guidance on planning airport ground access, circulation and automobile parking facilities. It describes these different elements within the terminal complex and the process used to plan these facilities. Included is a discussion of planning studies, key roadway and parking components (including key variables and inputs needed to plan for them), public transit and automated people movers, signage and wayfinding and emergency response vehicle routes.

8.2 Planning studies

Planning of new airport roadways and parking facilities should occur at the same time as planning and design of the terminal building, air cargo areas, general aviation terminals, and other land uses the roadways and parking facilities are intended to serve. Subsequent planning studies are frequently conducted to: (a) develop options to increase capacity, (b) address operational concerns, or (c) accommodate changes in the use of the terminal building or other land uses. It is important that the terminal roadways and parking facilities are integrated into the overall terminal planning process to ensure a balanced system. Such planning is often conducted within the context of an airport master plan.

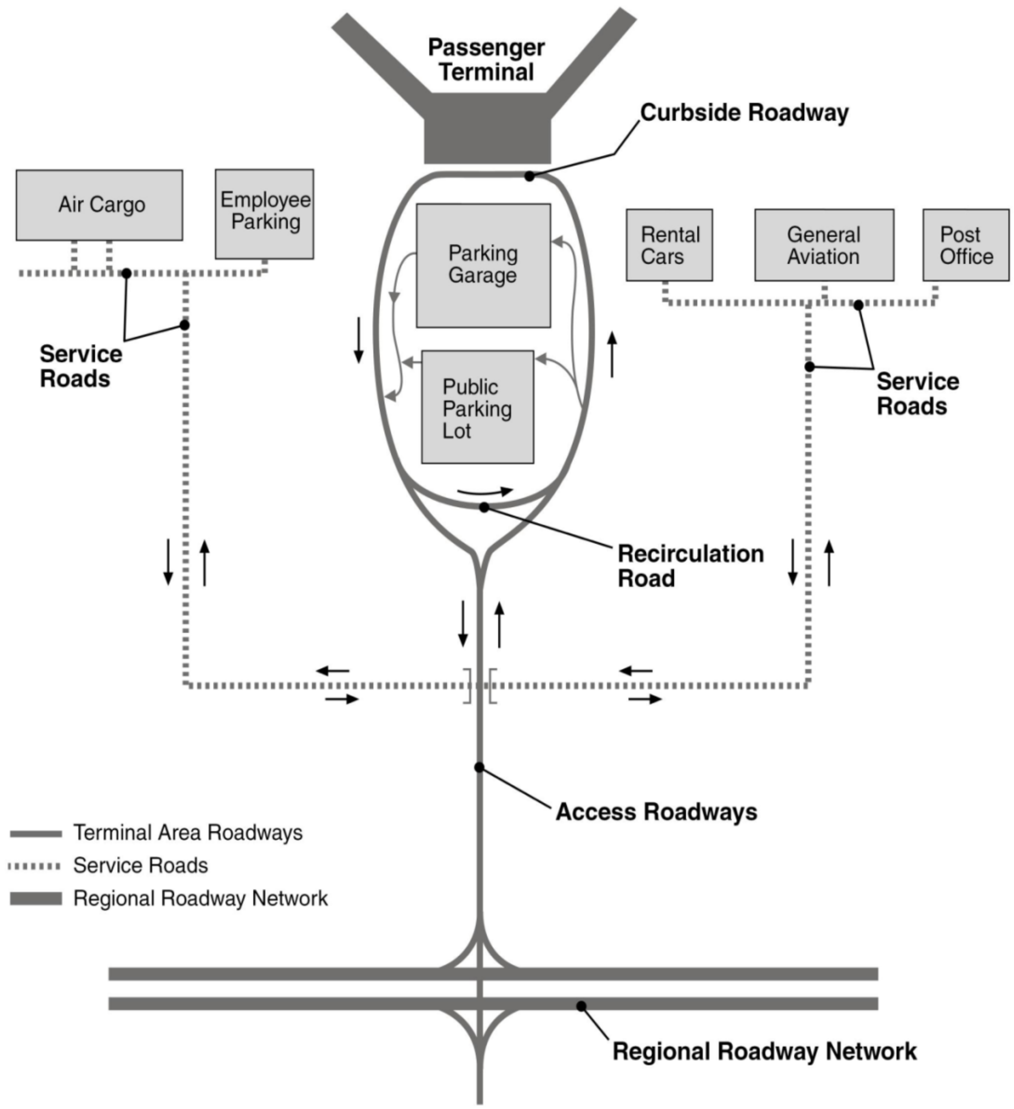
8.3 Key Roadway and Parking Components

The components of an airport roadway and parking network are described below and depicted in **Figure 8-1**.

- Access roadways – provide for the flow of traffic between the regional roadway network, local roadways and the terminal area and other major traffic generators located on the airport such as air cargo/freight terminals, general aviation terminals, and airline maintenance centers. Access for alternate modes, such as bicycle and pedestrian access may also be part of the transportation network.
- Curbside roadways – located adjacent to the terminal ticket lobby and baggage claim areas, are used to drop off and pick up airline passengers and their baggage.
- Recirculation roads – provide for motorists and commercial vehicles going back to the terminal or to a parking entrance after dropping off a passenger, or going to pick up a passenger after exiting a parking facility.
- Public parking structures or lots – includes: (a) short-term parking, serving visitors such as meeters/greeters and well-wishers parking their vehicles for a short-term period, (b) long-term parking serving airline passengers parking for a day or more, and (c) other parking offerings such as remote/economy parking, cell phone lots, valet parking or corporate reserved parking, and bicycle parking (typically for airport employees).
- Employee parking – reserved for persons working for the airport, airline employees (including based and non-based flight crews), and other tenants.

- Employee Screening - this can be accomplished outside the terminal building (e.g., at the curbfront) or inside the building either in an area dedicated to this function or adjacent the normal passenger security screening areas.
- Service roads – provide access to and circulation between non-terminal area land uses, and are primarily used by air cargo, service/delivery, and airport operations/employee vehicles as opposed to airline passengers and terminal visitors.

Figure 8-1 AIRPORT ROADWAY AND PARKING COMPONENTS



Source: ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations.*

- Airfield roads – located within the aircraft operating area and used only by authorized vehicles and drivers.
- Rental car areas – used to facilitate rental and return of rental cars, car storage, and ready/return functions (fueling, washing, and light maintenance) of rental vehicles.
- Commercial vehicle hold areas – used for brief parking or holding/staging of taxicabs, limousines, charter bus/vans, and other vehicles waiting for the arrival of airline passengers.
- Rideshare vehicle hold areas – specifically designated areas for staging and picking up passengers (airports are handling these services in a variety of ways).
- Loading docks – located in the terminal building where goods and products for food, beverage, and retail concessionaires are delivered and trash is removed.

8.4 Roadways

The planning and operation of airport roadways differs dramatically from the planning and operation of regional roadways. This is because motorists using regional roadways drive on the same roadways many times each week and are thoroughly familiar with the exit/entry locations, roadway directional signs, and likely points of congestion. In contrast, most motorists using airport roadways drive to the airport only a few times each year and are unfamiliar with the exit/entry locations, roadway signage, and likely points of congestion. In addition, due to concerns about potential delays, unfamiliarity with check-in procedures, or the desire to greet an arriving passenger on time, airline passengers are more stressed than typical commuters. This unfamiliarity and stress is aggravated by the complexity of airport roadways, which compared to regional roadways and arterials, contain more closely spaced decision points, more complex signs, and a higher proportion of taxicabs, limousines, scheduled and chartered buses/vans, shared-ride vans, and courtesy vehicles serving hotel/motels, and rental cars, (collectively referred to as commercial vehicles), and parking lots.

Planning for airport roadways and parking facilities begins with estimates of existing and future requirements. These requirements are generated by the airline passengers and visitors using the terminal buildings and other facilities served by the roadway and parking facilities. The estimated requirements are compared with the calculated capacity of the proposed or existing roadway and parking facilities to establish the ratio between requirements (demand) and capacity. The demand/capacity ratio helps define the LOS[*] for each roadway segment or parking facility.

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[*] The Highway Capacity Manual presents a detailed description of the Level of Service (LOS) concept and the methods used to calculate LOS on roadways having uninterrupted traffic flows (e.g., limited access freeways and arterials) and interrupted flows (e.g., signalized and stop sign controlled roads and streets). LOS is a qualitative measure used to describe the quality of traffic flow experienced by a motorist (or other facility user). Six levels of service are defined with LOS A being the best operation (i.e., free flow conditions with no delays or congestion); while LOS F represents a facility where demand exceeds capacity, resulting in frequent delays and prolonged congestion. LOS C, which represents stable flows at or near free-flow conditions with drivers experiencing comfortable and safe operations, is frequently selected as a goal for the planning of airport roadways due to consequences of passenger delays and the customer experience desired by most airports.

8.4.1 Roadway Level of Service

Roadway LOS goals should be established at the outset of a planning effort. As the planning process continues, the calculated LOS for each roadway segment and parking facility should be compared with these goals. The plans for those facilities not providing satisfactory LOS will be modified to increase the capacity and improve LOS (e.g., by adding roadway lanes, parking spaces, parking exit lanes, or eliminating unsatisfactory weaving operations).

8.4.2 Roadway Requirements

Airport access and circulation roadways are designed to accommodate the peak hour traffic demands projected for each roadway link or component. The peak hour volumes may be defined as the volumes occurring during the peak hour of an average day during the peak month, the 30^{th} highest hour, or the peak hour occurring during a standard busy day. The peak hour for vehicles transporting originating airline passengers to the airport typically precedes the peak aircraft departure hour by 1 to 2 hours, while the peak hour for vehicles transporting terminating airline passengers from the airport typically lags the peak aircraft arrival hour by the same amount. The amount of "lead" and "lag" time depends upon the proportion of international/domestic passengers, business/leisure passengers, aircraft size and load factors, and other factors.

Two common methods to determine roadway requirements or peak hour roadway traffic volumes are summarized below:

1. **Volume and Mode Choice**. Calculate the volumes generated by each airport land use (e.g., airline passenger terminal building, air cargo areas, and general aviation terminal) and determine the access/egress routing patterns of these traffic volumes. Future roadway traffic volumes can be calculated based upon estimates of the number of originating and terminating airline passengers, number of employees, and volume of cargo, adjusting for future travel patterns (e.g., changes in the proportion of traffic approaching/departing the airport from different directions), mode choice (e.g., anticipated increase in the use of public transit), and other changes. However, this method requires a large amount of input data to calculate the volume of traffic generated by airline passengers, visitors and employees, and airport service and delivery vehicles, and to determine the current circulation patterns of these vehicles.

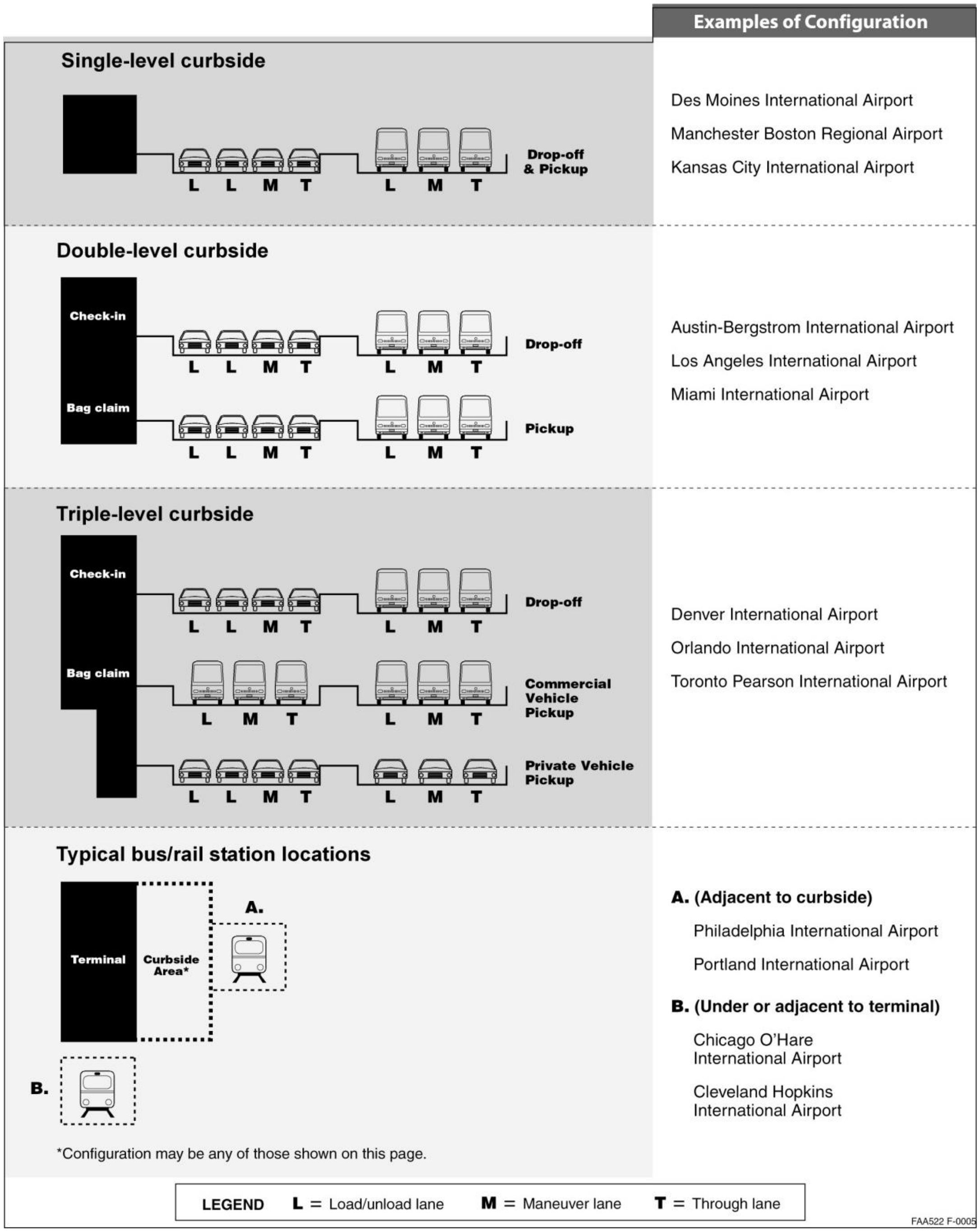
2. **Peak Hour**. Increase the existing peak hour traffic volumes on each roadway link in direct proportion to the forecast growth of design hour airline passengers or other indices of future growth. Existing peak hour traffic volumes can be determined through automated traffic surveys or manual surveys if vehicle classification data are needed.

ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations* presents detailed information about calculating airport roadway requirements.

8.5 Terminal Curbside

Curbside roadways consist of inner lane(s) in which vehicles stop in a nose-to-tail manner to drop off or pick up passengers, an adjacent maneuvering lane, and one or more bypass lanes. Usable curbside space does not include space occupied by crosswalks, reserved for police, emergency, or other vehicles, or otherwise not available to private or commercial vehicles. However, it is desirable to also consider the extent of double parking at the inner lanes, the number of bypass lanes, and the interaction between bypass traffic and traffic entering and exiting the curbside lanes. For example, three-lane curbside roadways are undesirable because when double-parking occurs, only a single by-pass lane remains. Traffic flow on the remaining single lane may be obstructed or delayed as double-parked vehicles enter and exit the bypass lane. A generalized depiction of the terminal curbside is presented on **Figure 8-2**.

Figure 8-2 AIRPORT CURBSIDE COMPONENTS



Source: LeigFisher, 2014.

8.5.1 Curbside Level of Service

The LOS of a curbside roadway is determined by analyzing the demand/capacity or volume/capacity ratio for both the inner curbside lanes and the maneuver lanes, with the lanes having the poorest level of service governing. The LOS on the inner curbside lanes is defined by the proportion of double-parked vehicles with a curbside having 30% of the vehicles double-parked (assuming the entire inner lane is occupied) defined as LOS C. The volume/capacity of the bypass lanes is determined by comparing the volume of bypass traffic with the capacity of the bypass lanes, which varies depending on the LOS of the curbside lanes.

8.5.2 Curbside Requirements

Airport curbside roadway requirements are typically calculated to accommodate the volume of traffic occurring during the peak 15 to 20 minutes of the peak hour. This is because traffic flows are not distributed uniformly throughout the peak hour, and a sudden peak or burst of traffic can result in congestion and delays. In addition, curbside demand is not distributed uniformly along the face of the terminal and tends to be higher near skycap bag check-in locations, doorways serving popular airlines, and in locations away from columns and the most distant curbside sections.

The following key inputs used to calculate airport curbside roadway requirements.

- Volume – refers to the number of vehicles stopping at each curbside to drop off or pick up airline passengers and number of “bypass” vehicles driving past but not stopping at a curbside.
- Vehicle mix – the different types of private and commercial vehicles.
- Vehicle dwell times – the length of time vehicles remain stopped at the curbside.
- Curb space – the average length of curb space occupied by each type of vehicle including the space required to maneuver into and out of the curbside area.

The level of enforcement an airport operator uses can also be a significant factor in determining curbside roadway requirements.

Detailed information about airport roadway capacities, commercial ground transportation and LOS are contained in:

- ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*
- *Intermodal Ground Access to Airports, a Planning Guide* (FAA, FHA, Bellomo-McGee, Inc., 1996)
- ACRP Report 146, *Commercial Ground Transportation at Airports: Best Practices*

8.6 Parking facilities

Parking facilities accommodate for the needs of airline passengers, airport visitors, and persons working on the airport. The planning and operation of airport parking facilities is different from that of parking facilities serving offices, retail centers, hospitals, or downtown areas. Airport parking facilities can be very large. Some contain over 5,000 spaces, with a high percentage of the spaces occupied for 24 hours or more – which is a key factor that is unlike parking facilities serving other uses. Airport parking facilities are also an important source of airport generated revenue (representing as much as 25% of total airport revenues) and an important contributor to the customer's overall travel experience.

8.6.1 Public Parking

Public parking structures or lots include the following:

- Short-term parking – serving visitors such as meeters/greeters and well-wishers parking their vehicles for four hours or less; sometimes referred to as "Hourly Parking".
- Long-term parking – serving airline passengers parking for the duration of their trip in facilities located within a convenient walking distance of the terminal or remotely located spaces requiring a longer walk or the use of a shuttle bus; sometimes referred to as "Daily Parking" while those located away from the terminal and requiring the use of shuttle bus are sometimes referred to as "Economy" or "Remote Parking".
- Other parking products – includes other parking offering such as remote/economy parking, cell phone lots, valet parking or premium- and corporate-reserved parking.

8.6.2 Reserved Parking

Parking facilities reserved for non-public use include:

- Employee parking – for persons working for the airport, the airlines (including based and non-based flight crews) or other tenants.
- Rental car areas – used to store cars for customers renting or returning a car, store out-of-service vehicles for short periods, and perform fueling, washing, and light maintenance of the rental car vehicles.
- Commercial vehicle hold areas – used for brief parking or holding/staging of taxicabs, limousines, charter bus/vans and other vehicles that are waiting for the arrival of airline passengers.
- Rideshare vehicle hold areas – specifically designated areas for staging prior to passenger pick-up.

8.6.3 Parking Level of Service

There are no formally accepted measures to define the optimum LOS of a parking facility. Key factors typically considered include: (a) the ratio of peak period requirements to facility capacity with a ratio of 85% typically representing the limit of an acceptable LOS, and (b) the proportion of spaces located within an unassisted walking distance of 600 to 800 feet of a terminal building entrance; ideally with all close-in spaces located within this walking distance. Other factors include the length of peak period exit delays, search time for an empty space, and passenger comfort which is affected by vertical clearance, openness, illumination levels in parking aisles and pedestrian paths, and other design factors.

8.6.4 Parking Requirements

Airport terminal area and economy parking facilities are planned to accommodate requirements occurring on an average day of a peak month, or more commonly a standard busy day during the peak month. When data are available, planners often prepare histograms depicting the observed peak parking accumulation for every day (or hour) of an entire year in order to select the appropriate design day and its demands. Many airports have remote lots that are only used for overflow parking during holiday periods or other times of peak demand. Because it is not economical to build and operate spaces that are rarely used, these lots are often not developed to the same level of durability as regularly used parking facilities.

Public parking requirements typically increase in direct proportion to increases in the volume of originating and terminating airline passengers, with allowances for anticipated changes in the travel mode choice, or other exceptions. For example, an anticipated increase in the proportion of airline passengers travelling by public transit could potentially result in a corresponding reduction in parking requirements. Short-term (hourly) parking requirements can be estimated considering the expected change in peak hour airline passengers, while long-term (Daily and Economy) parking can be estimated considering the expected change in monthly or annual passengers. Typically, 70% to 80% of the spaces are occupied by long-term parkers because the spaces they occupy turnover infrequently.

Employee parking often is located in multiple surface lots adjacent to major employment centers, with very few airports providing multi-level parking structures solely for employee use. Parking adjacent to the terminal building may be reserved for senior employees of the airlines and other tenants, and employees of the Federal Government (e.g., the FAA, TSA, and CBP), with other employees working in the terminal building required to park in remote lots. These lots are sized to accommodate the peak demands which frequently occur at the time of employee shift changes.

A large public or employee parking facility is typically planned to include a 10% circulation factor, which increases the space count (e.g., if 1,000 spaces are needed to accommodate demand, 1,100 spaces should be built). This factor allows for vehicles that circulate within the facility because it is difficult to find the last space in a large parking facility, and improperly parked vehicles that occupy two spaces. With single space parking detection systems, which make it possible to direct customers to every empty space, the circulation factor may be reduced to less than 10%.

Local code requirements typically specify the number of parking spaces (and their size and location) that must be reserved for disabled passengers. Also, the location of parking facilities near a terminal building may be determined by federal security regulations and the policies of individual airports.

8.7 Public Transit and Automated People Movers

Public transit includes traditional fixed-route, multi-stop public bus service, express bus services, shared-ride vans, and scheduled rail service. Most airports are served by: (a) scheduled public buses; (b) express bus services linking the airport directly with downtown or other popular destinations, and (c) shared-ride van services that use 7 to 10-passenger vans and make multiple stops enroute to and from an airport. As a result, at most airports the transit facilities consist of dedicated curbside passenger drop-off and pick-up areas, with perhaps a bus shelter or an enclosed, weather-protected passenger waiting area.

8.7.1 Rail Transit

Several airports offer direct rail connections (e.g., one-seat rides on trains) between the airport terminal and the downtown area. Other airports offer rail access but require a transfer using an intermediary travel mode (e.g., a two-seat ride). Typically rail (and bus) services are planned in coordination with the local transit operator and other agencies. The following are key considerations when planning rail transit:

- Ability to preserve future aviation related development opportunities and flexibility to accommodate unforeseen development.
- Walking distances and number of level changes between the transit stop/platform and the airline ticket counters and baggage claim areas.
- Ability for passengers with baggage to pass through turnstiles and enter/exit transit stations both at the airport and other stations.
- Ability to board the transit vehicle for passengers with several pieces of baggage.

Additional information about the use of public transit and planning for public transit facilities at airports can be found in:

- TCRP Report 62, *Effects of TOD on Housing, Parking, and Travel*
- TCRP Report 83, *Strategies for Improving Public Transportation Access to Large Airports*
- ACRP Report 4, *Ground Access to Major Airports by Public Transportation*

8.7.2 Automated People Mover Systems

Automated People Mover (APM) systems at airports are used when a large number of passengers must be transported on a frequent basis between two points or between multiple points. APM systems can be classified by those that provide:

- Transportation post security such as between a landside terminal building and a remotely located airside concourse (e.g., the airports serving Atlanta, Denver, Miami, Orlando, Pittsburgh, Seattle, Tampa, and Washington-Dulles) or at airports having unit terminal buildings (e.g., the airports serving Dallas/Fort Worth, Detroit, and Houston Intercontinental).
- Transportation pre-security such as between the terminal buildings and either (1) a consolidated rental car center or parking structure (e.g., at Atlanta, Phoenix, San Francisco), and/or (2) other unit terminal buildings at airports where some connecting passengers must exit security (e.g., Chicago O'Hare, John F. Kennedy, Minneapolis-St. Paul international airports).

Key considerations when planning APM systems include:

- The capacity of each car, since passengers on pre-security APM systems have more and larger pieces of baggage per person than do passengers on post-security systems
- Peak hour loads on the busiest guideway segment or station-to-station link. The number of required cars (and train size) is a function of the peak load, the vehicle capacity, and the desired headways.
- Guideway geometry and alignment which is established by the type of APM system (e.g., self-propelled vs cable pulled).

- Station design to allow for the separation of boarding and alighting passengers, space for waiting passengers, and as well as escalators and elevators frequently needed to connect to elevated or underground stations. Design should also consider providing alternative walkways for passengers for times when the APM is inoperable.
- Vehicle maintenance and storage yards which are often located at the end of the line.

The choice of APM versus shuttle bus depends on the desired customer experience (flat boarding and alighting for an APM versus climbing steps for a shuttle bus), capacity required to accommodate the expected passenger demands, the travel distance (most APM systems are less than one mile in length), and costs with the life-cycle costs of an APM (capital costs plus operations & maintenance costs) being much more than a shuttle bus.

ACRP Report 37, *Guidebook for Planning and Implementing Automated People Mover Systems at Airports* provides detailed information about the planning and design of APM systems and presents information about the various types of system configurations (e.g., shuttles, loops, and pinched loops) and equipment.

8.8 Landside Signage and Wayfinding

Roadway and parking facility signage includes warning signs (e.g., Stop and Yield), regulatory signs (e.g., No Parking, Speed Limit), and directional or wayfinding signs. A detailed description of the design and application of warning and regulatory signs can be found in the *Manual on Uniform Traffic Control Devices* (MUTCD) published by the Federal Highway Administration, which contains information about the planning and design of directional signs for regional roadways and streets. A detailed description of the planning and design of directional and wayfinding signs for airport roadways and parking facilities can be found in ACRP Report 52, *Wayfinding and Signage Guidelines for Airports*.

The planning of wayfinding signs for airport roadways and parking facilities begins when plans for these facilities are first developed. Wayfinding should be an integral part of the planning process, rather than being considered only after the design is complete.

Airport roadways should be planned to simplify wayfinding by motorists. This can be accomplished by providing:

- Adequate time for motorists between successive decision points so that they can recognize that they are approaching a decision point, read the signs, and safely react to the information provided.
- Binary decision points and avoidance of three-way roadway splits.
- Uniform roadway exit patterns (e.g., placing exits/entrance consistently on the same side of the road).
- Simple messages that can be quickly read and understood, and which minimize confusion.
- Adequate capacity for weaving maneuvers considering the number of lanes to be crossed, vehicle speed, the volume of traffic, and weaving distance.
- Design standards to regulate or prohibit distractions near directional signs such as billboards, banners, or other devices.
- Regulatory signs that enable law enforcement to manage roadways/curbs and prohibit unattended vehicles.

The need for simple wayfinding signs is highlighted by the number and complexity of decisions encountered by motorists entering a major airport, and the high proportion of motorists who rarely use the airport and are unfamiliar with its roadways. When planning and signing a parking structure or lot, priority should be given to the needs of pedestrians rather than motorists. Motorists simply need to find an empty space and an exit. Customers on foot need to be reminded where they parked their car, as well as how to walk to/from the terminal.

It is advisable to provide many reminders to help customers recall the level, aisle or section of a parking facility where they left their car. These reminders may include the use of a combination of colors, letters, symbols, and names, and repeating these devices along the path the customer follows when walking from their car to the terminal. Brightly lit aisles and pathways can help guide customers. Being able to see the terminal or other object/view through the parking parapet can help orient pedestrians. For safety and convenience it is desirable to provide good lines of sight and avoid locations where intruders can hide within a parking structure.

CHAPTER 9. SUSTAINABILITY IN TERMINAL PLANNING

9.1 General

This chapter provides guidance on airport sustainability considerations that can be made for anyone initiating an airport terminal-related project. This includes an overview of sustainability practice and relevant practices.

9.2 Airport Sustainability Practice

Sustainability is a set of practices and principles that focuses on high and stable levels of economic growth, operational efficiency, preservation of natural resources, and social responsibility.[1] This is accomplished by evaluating the carrying capacity of regional, national, or Earth systems (the atmosphere, resource capacity, etc.) when planning, designing, building, and maintaining facilities, developing public policy, and running organizations.

The goal of these efforts is to achieve sustainable growth – growth that assures high quality of life and environmental quality in our generation without compromising the needs of future generations, or damaging Earth systems. Global sustainable development principles are generally linked to a report produced by the Brundtland Commission, a commission formed by the United Nations.

Airport sustainability incorporates economic, environmental, and social considerations into planning, design, construction, operations, and maintenance through a concept called the "Triple Bottom Line." High and stable levels of economic growth, environmental quality, and social responsibility are the "three" pillars of sustainability. In addition to the three pillars, the airport industry adds "operational efficiency" as an equal consideration. This is called the EONS approach (economics, operations, natural resources, and social responsibility) to airport sustainability.[2] See **Figure 9-1**.

[1] Sustainable Aviation Guidance Alliance (SAGA).
[2] Ibid.

Figure 9-1 EONS Approach

Source: SAGA, http://www.airportsustainability.org/

To some degree, airports already integrate some sustainability practices without explicitly identifying them as such. Examples include energy efficiency and emissions reduction projects, solid waste recycling, reusing construction and demolition materials, economic analysis of proposed development, and community outreach. Sustainability practice institutionalizes these considerations by overtly incorporating the concept into "traditional' processes such as airport planning. This approach results in a discrete and robust set of sustainability goals and initiatives that can be tracked and easily implemented. This also enables airports to identify sustainability benefits and report sustainability accomplishments.

Resources that provide in-depth explanations and information on airport sustainability include:

- ACRP Synthesis 10, *Airport Sustainability Practices*: This synthesis includes a list of focus areas for each sustainability pillar, and corresponding sets of practices.
- The Sustainable Aviation Guidance Alliance (SAGA): Established by a coalition of aviation interests, SAGA has a website with specific airport sustainability projects. It includes airport points of contact, and descriptions of the projects and benefits.
- ACRP Report 119, *Prototype Airport Sustainability Rating System*: This report outlines a prototype airport-wide sustainability rating system that airport operators can use to improve sustainability performance. This includes terminal buildings. The report also compares other rating systems and sustainable design processes.
- Airport Recycling, Reuse, and Waste Reduction Plans: Provides information on airport recycling, reuse and waste reduction. For federally obligated airports, see, FAA Guidance on Airport Recycling, Reuse, and Waste Reduction.

There is an impression that sustainability is primarily focused on the environment. This is not the case. In the "Triple Bottom Line" and EONs frameworks, environment, economics, social responsibility, and operational efficiency are equally considered. It is possible to pursue airport initiatives that intersect with multiple "sustainability pillars." For instance, an energy efficient terminal can save money while reducing environmental impacts. A low emissions vehicle can reduce harmful emissions while saving money on fuel and maintenance during the vehicle's life cycle. Maximizing recycling capacity may provide opportunities to increase revenue while reducing material usage and operational costs. Evidence of this balance can be found in airport planning documents that incorporate sustainability. Some airports prioritize economics while others prioritize environmental aspects when outlining their sustainability vision. Despite the different initial orientations, the actual sustainability practices are roughly the same.

The key is to identify measures that, either individually or collectively, will "sustain" the airport – as an economic engine in a region, a positive contributor to the community, and an attractive workplace for employees and tenants, all while proactively minimizing environmental effects. An effective sustainability approach achieves operational efficiency *while* minimizing environmental impacts, benefiting the community and contributing to the local economy. Through careful planning, it is possible to achieve all four objectives.

9.3 Airport Sustainability Planning

Airports typically consider sustainability in planning documents such as airport sustainability plans, through sustainability reporting, and in operations and maintenance. Sustainability plans can either be integrated with an airport master plan or stand-alone sustainable master plan. In general, these plans include baseline analyses of sustainability focus areas. Following are some examples:

- Air quality and emissions reduction.
- Recycling, reuse, and waste reduction.
- Energy conservation, efficiency, and renewable energy.
- Sustainable capital improvements (sustainability considerations of capital improvements during the master planning period).
- Airport connectivity and multimodal development.
- Sustainable land use.
- Sustainable design and construction.
- Climate adaptation and resilience.
- Natural resources management.
- Community outreach.
- Employee well-being.

Baseline analyses of these focus areas are used to identify sustainability initiatives or practices during the planning period, and establish a method to implement the objectives and track progress.[3]

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[3] For additional information on sustainability practices resulting from this approach, see ACRP Synthesis 10, the Sustainable Aviation Guidance Alliance (www.airportsustaianbility.org), and the FAA sustainability webpage (www.faa.gov/airports/environmental/sustainability. Several airport authorities also have robust sustainability programs.

9.4 Sustainability in Terminal Development

Aspects of terminal development that are relevant to sustainability include terminal siting and access, building design and characteristics, terminal power sources, energy efficiency, conservation and management, terminal emissions, and terminal recycling, reuse, and waste reduction. The following sections outline key sustainability considerations.

9.4.1 Terminal Siting and Access

When possible and in accordance with AC 150/5300-13, *Airport Design*, terminals should be sited to minimize taxi distances from runways and taxiways to reduce fuel consumption and emissions of taxiing aircraft, and minimize noise impacts to surrounding communities. Sustainable terminal design also prioritizes intermodal connectivity through rail and transport links, and an efficient layout of the terminal, parking areas, and airport-related facilities (such as rental car providers and other support facilities). Sustainability objectives include:

- Minimizing motor vehicle transport to/from the terminal, thereby reducing fuel consumption, emissions, traffic impacts, and motor vehicle dependence.
- Minimizing fuel consumption, emissions and congestion for airport and tenant vehicles.
- Planning for convenient and integrated public transport to and from the terminal, efficient mass transit options between terminals, and convenient access to the local community. When possible, integrating these considerations into municipal plans.

Improving public transport around an airport may be outside the scope of airport or terminal planning, but provisions can be made for multimodal facilities in a terminal plan. This includes light, conventional or high-speed rail systems, and regional and local bus facilities. All facilities should be designed for convenient passenger and employee access. Airports should coordinate with municipalities early in any planning process to ensure these considerations are also included in municipal plans.

9.4.2 Building Design and Characteristics

A key sustainability consideration in building design is efficient energy use and energy waste. Energy use can be optimized through the use of energy efficient power sources, attention to building form and orientation, building envelope, natural light and ventilation, shading, height-to floor ratios, and systems that can optimize heating, cooling, and electrical energy use. All of these decisions can maximize passive ventilation and cooling, and reduce energy requirements.

Buildings should also be designed with consideration of the sustainability and nature of materials used, the way the terminal represents its distinctive, local context, and appropriateness for the environmental setting. Considerations such as climate, vegetation, the character of surrounding or distinctive buildings in the area, local culture, and community values can create a structure that integrates with its environment.

In some cases, and particularly where there is a local legacy of civil aviation, terminal planning can continue that legacy through parameters that evoke the origins of civil aviation (to the extent practicable in the current operating environment). In this context, the planning approach is more sustainable through an understanding of the local environment, not solely internal planning considerations or the tendencies of a particular designer.

These considerations can also prevent the introduction of design features that require additional care and maintenance in the local climate. Examples include optimal orientation to take advantage of natural wind and sun patterns, use of surfaces that minimize "heat island" effects in warmer climates, etc.

Sustainability objectives include:

- Planning a structure that integrates with the local environment and increases its value as an attractive destination.
- Orienting the building to take advantage of natural light and ventilation, and include design features that minimize energy needed to heat, cool, and light the structure.
- Ensuring the building envelope and design features minimizes energy waste.

9.4.3 Terminal Power Sources

Careful evaluation of the capacity of energy sources in a given area is important to determining whether the terminal will affect the sustainability of regional power supplies. In all cases, and especially with new buildings, energy efficient power sources should be maximized. For the purposes of this section, energy efficiency is achieving the same level of service with fewer energy inputs (such as fossil fuels).

In general, the most efficient power sources are those that waste less energy during the conversion or refining process from a "fuel" (fossil fuels, sunlight, wind, etc.), and during transmission to a specific end use (heat, cooling, electricity, etc.). In this context, renewable power sources such as geothermal and solar are more efficient than fossil fuels. Efficiency is also improved through co-generation or tri-generation, when energy used for electric power is also used for heat or other purposes.

Please note that efficiency is distinct from cost-effectiveness. Some renewable sources require a larger up-front capital investment. Despite this, it is possible to generate cost savings, particularly when utilizing incentives such as grants funding or seeking partnerships (such as Energy Savings Performance Contracts) where outside entities will build a renewable power source in exchange for some of the cost savings. It should be noted that Airport operators considering renewable power sources need to ensure that new installations comply with FAA airport design standards (e.g. AC 150/5300-13, 14 CFR Part 77, etc.) and do not adversely affect airport operations. Coordinate with the FAA staff early in the process.

Connecting renewable power sources through a smart grid or micro grid can also ensure a sustainable energy supply that remains independent of fluctuations in the power grid. This can increase energy security. When combined with systems that optimize energy use based on demand, this can also optimize energy use and reduce energy waste.

Terminal energy assessments, audits, or management plans can help determine baseline energy usage and future energy needs. They can also be used to identify practices or initiatives that will increase energy efficiency of power sources and energy use for terminal buildings. When possible, energy audits should be for the entire airport. These can be integrated into a sustainability plan or a stand-alone effort. This will result in airport-wide measures that can also benefit terminals.

Sustainability objectives include:

- Maximizing use of energy efficient power sources.
- Evaluating the potential for smart grids and micro grids that increase energy security and optimize energy use.
- Completing airport-wide energy assessments, audits, or plans with corresponding energy efficiency objectives.

9.4.4 Energy Efficiency, Conservation, and Management in Terminal Buildings

Terminal planners should consider the latest energy efficiency certification and recertification processes. One example is Leadership in Energy and Environmental Design (LEED). LEED has a point-based system that can be referenced to develop a more sustainable building. Buildings can be certified as LEED Silver, Gold, or Platinum depending on the extent to which LEED practices are incorporated into subsequent design. There is also LEED certification for existing buildings (LEED-EB) that can improve building performance.

Though LEED certification is sometimes sought for new airport buildings and some existing buildings, LEED practices may not always be suitable in an airport environment (e.g., high numbers of bike racks in a vehicular environment). Therefore, even if LEED is referenced, airport-specific considerations may affect the ultimate level of LEED certification one attains, or even if certification is sought.

For this reason, airport operators should evaluate a wide variety of sustainability rating and design systems to determine which is appropriate for a given project. Reference ACRP Report 119, *Prototype Airport Sustainability Rating System*, for comparisons between various sustainability ratings systems and certifications.

Smart building design that takes advantage of natural light and passive ventilation can also contribute to an energy conservation strategy by reducing the amount of energy needed for a terminal building.

"Smart" building technologies such as computer controls, sensors and whole-building automation (such as Building Automation Systems [BAS]/Building Energy Management [BEM] systems can help airport operators consider the functioning of the building as a system, rather than focusing on individual energy-using devices. Once a terminal is constructed, building recommissioning ensures building systems are functioning as originally planned and designed.

These systems and approaches enable heating, cooling, and electricity to react automatically to the operating environment to optimize energy efficiency. Features include automatic adjustment of external shades or louvers that track sunlight and heat load to maximize light and control solar heat load. Plantings such as green roofs can be used to lower ambient temperature. All of these systems and features can be included in a terminal plan.

Furthermore, if the heating, cooling and electricity needs of a collection of buildings can be linked together in an integrated system without major distribution losses, significant energy savings are possible. This can benefit the terminal and the airport environment.

Sustainability objectives include:

- Maximizing use of energy efficient power sources.
- Evaluating the potential for smart grids and micro grids that increase energy security and optimize energy use.
- Completing airport-wide energy assessments, audits, or plans with corresponding energy efficiency objectives.

9.4.5 Terminal Recycling, Reuse, and Waste Reduction

Waste from terminal buildings can be one of the single largest waste streams on an airport. Maximizing recycling, reuse, and waste reduction can significantly reduce the waste stream and associated costs. In some instances recycling/reuse of waste can provide opportunities to generate airport revenue. Airport recycling, reuse, and waste reduction plans are a required element of FAA-approved airport master plans or master plan updates. Developing this plan can provide opportunities to evaluate recycling when planning terminal buildings, expand recycling programs, and reduce costs. For more information, see AC 150/5070-6, *Airport Master Plans* and FAA Guidance on Airport Recycling, Reuse, and Waste Reduction

The terminal's proximity to municipal (or on-airport) recycling facilities is a key consideration when developing a recycling plan. The ability to recycle municipal solid waste or construction and demolition materials is often dependent upon this capacity. When possible, airport operators should coordinate with municipalities to advocate for municipal recycling facilities.

Terminal contracts are a way to ensure sustainability is integrated into terminal construction, and concessions, cleaning and maintenance, and other aspects of building operation. ACRP Synthesis 42, *Integrating Sustainability into Airport Contracts*, is a useful reference.

Sustainability objectives include:

- Maximize recycling, reuse, and waste reduction in terminal construction and operation.
- Plan and advocate for increased municipal recycling capacity.
- Integrate sustainability into terminal contracts.

9.4.6 Terminal Emissions

Terminal siting and design, the materials and technologies used for the building, can greatly reduce emissions that are harmful to local air quality and increase atmospheric concentrations of Greenhouse Gases (GHG). This includes the use of power to reduce aircraft ground emissions through gate electrification and pre-conditioned air for aircraft at terminal gates. Analyses of terminal emissions and GHG inventories can aid planning that reduces emissions during building operation.

Sustainability objectives include:

- Completing analyses and inventories that improve understanding of terminal emissions, and can facilitate development of emissions reduction measures.
- Consider the use of terminal power to reduce aircraft ground emissions.
- Pursue an energy efficient design, with efficient power sources, that can benefit air quality and reduce GHG emissions.

9.5 **Other Sustainability Considerations**

9.5.1 Climate Change Adaptation and Resilience

Climate change adaptation and resilience is a process of identifying projects or improving facilities to adapt to changing climatic conditions. This process is normally conducted on a regional or local level through analysis of the potential impacts of climate change, and terminal needs. This ensures terminals can remain in operation or quickly recover from a climate-related event. Potential impacts of climate change include sea level rise during the planning period, changing frequency or intensity of storms or floods, or alterations in weather patterns.

Several municipalities and airport authorities are developing broader climate plans that can inform terminal planning, either within the same geographic area or airport authority, or for terminals being planned in the same region. These effects should be considered in a terminal plan, or in an airport-wide sustainability or adaptation plan.

For more information, see ACRP Report 147, *Climate Change Adaptation Planning: Risk Assessment for Airports*

9.5.2 Social Sustainability and Terminal Planning

Social sustainability can be achieved through terminal plans that allow easy access to the airport through public transit, open houses, meeting spaces, an inclusive terminal design process, features that generate local economic activity (such as conveniently located businesses outside the sterile area), and a terminal building that reflects local culture.

Sustainability objectives include:

- Prioritizing an aesthetic approach that creates a "sense of place" for building occupants, ideally one that is recognizable in the context of the built environment.
- Planning terminals that will have the essential features for building occupants well-being: high indoor air quality, excellent employee facilities, natural light, and a layout that will make the airport both a desirable place to work and local destination.
- Evaluating how amenities between sterile and non-sterile areas affect how the community interacts with the airport, and passengers interface with the local community.
- Including the local community in the planning process and building operation. This includes allocating spaces for local contributions (installations for local art or descriptions of distinctive aspects of the local area, etc.), and highlighting what the airport is doing to remain a good neighbor and local economic engine.

9.5.3 Economic Sustainability and Terminal Planning

As stated earlier, sustainability evaluates social and economic costs on an equal basis with environment. Therefore, these and other sustainability considerations should be supported with economic analyses that ensure the continued economic vitality of the airport, its employees, and the surrounding community.

Though some sustainability initiatives require up-front investment, most can achieve a considerable return on investment throughout the useful life of the facility. For instance, in areas with reduced water capacity or issues with the electric grid, sustainability measures can save the airport money while minimizing burdens on local systems or resources. The overarching sustainability objective in a terminal plan should to be to minimize environmental impacts *while* ensuring operational efficiency, economic growth, employee well-being, passenger convenience, and a strong relationship with the community.

CHAPTER 10. PLANNING CONSIDERATIONS FOR NON-HUB TERMINALS

10.1 General

This chapter provides additional considerations that should be made for non-hub airports when planning a new, renovated or expanded terminal facility. The process of planning and designing a non-hub terminal facility is fundamentally the same as it is for larger airports. Non-hub airports need to assess their situation before beginning the process, much like their larger counterparts. It is also important to have alignment and documentation around the goals & objectives of the project. Stakeholder input, and the technical aspects of the project are also important although likely at a smaller scale. The following sections highlight some areas non-hub airports should pay particular attention to:

- Volatility.
- Flexibility in planning.
- Financial realities and risk.
- Stakeholder involvement.

10.2 Volatility

Non-hub airports are more vulnerable to shifts in the economy and air service decisions made by airlines. As a result, they are more likely to experience changes in demand, more unpredictable revenue streams from airlines and concessions, and more drastic changes in their operation.

This factor is something that should be carefully considered by non-hub airport owners/operators. ACRP Report142, Effects of Airline Industry Changes on Small- and Non-Hub Airports specifically discusses this topic.

10.3 Flexibility in Planning

Guidance routinely used for determining the sizing of facilities assumes that the airport owner/operator will plan for peak hour activity. However, at non-hub airports where there are few peak periods, the space program should be completed using the models discussed in earlier chapters; however once the planners begin to look at building layouts, the square footage assumptions should be revisited to ensure the facility is not oversized.

In terms of the physical layout of facilities, it is wise for non-hub size airports to consider simple expansion scenarios and construction techniques so that it is most economical and efficient to expand if activity levels increase due to air service growth. This holds true for airline ticketing areas, bag claim, as well as gates.

10.4 Financial Realities and Risk

Smaller airports often operate on tight, fixed budgets. In some cases, their operation is subsidized by the owning entity, using non-airport funds. Because of this, non-hub airports must be keenly aware of the financial risks inherent in a terminal improvement program.

Operating budgets can also be smaller on a per passenger basis for non-hub airports. This is something that should be kept in mind when deciding on the sizing of a facility, some of the facility details such as finishes (choosing those that hold up longer and/or require minimal upkeep).

CHAPTER 11. MISCELLANEOUS PLANNING CONSIDERATIONS

11.1 General Aviation Terminals

The planning and design of general aviation terminal facilities are generally outside the scope of this AC. For information on the topic, see AC 150/5300-13, *Airport Design* and ACRP Report 113: *Guidebook on General Aviation Facility Planning*.

11.2 Hazardous Wildlife Attractants

During the planning and design process it is advisable to understand, weigh and mitigate the potential that facility design may have on attracting wildlife. Changes made to terminal facilities (e.g., architectural treatments, introduction of landscape vegetation, etc.) and adjacent land uses have the potential to attract hazardous wildlife on or near public-use airports. Examples include; exposed beams becoming bird perches or nesting locations, airport landscaping featuring vegetation that attracts wildlife, and cell phone lots and taxi staging areas that could introduce new sources of food waste that can attract hazardous wildlife. For more information see AC 5200-33, *Hazardous Wildlife Attractants on or Near Airports*.

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APPENDIX A. LIST OF ACRONYMS

AC	Advisory Circular
ACI	Airports Council International
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
ADG	Airplane Design Group
ADPM	Average Day of the Peak Month
ALP	Airport Layout Plan
ATCT	Airport Traffic Control Tower
CBP	Customs and Border Protection
DHS	Department of Homeland Security
EQA	Equivalent Aircraft Factors
FAA	Federal Aviation Administration
FIS	Federal Inspection Services
GSE	Ground Service Equipment
HVAC	Heating Ventilation and Air Conditioning
IATA	International Air Transport Association
LOS	Level of Service
O&D	Origin and Destination
PBB	Passenger Boarding Bridge
ROM	Rough Order of Magnitude
RON	Remain Overnight
SARA	Service Animal Relief Area
SIDA	Security Identification Display Area
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
TSA	Transportation Security Administration

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APPENDIX B. REFERENCE MATERIALS

B.1 FAA Advisory Circulars

Below is a list of ACs that are mentioned in the previous sections of this AC, which provide specialized guidance or reference information related to the process of planning or designing airport terminal facilities. Additionally, a directory of all FAA ACs is available at the following location, http://www.faa.gov/airports/resources/advisory_circulars/

- AC 150/5050-4, *Citizen Participation in Airport Planning*
- AC 150/5070-6, *Airport Master Plans*
- AC 150/5100-14, *Architectural, Engineering, and Planning Consultant Services for Airport Grant Projects*
- AC 150/5220-21, *Aircraft Boarding Equipment*
- AC 150/5300-13A, *Airport Design*
- AC 5320-6, *Airport Pavement Design and Evaluation*
- AC 150/5340-1L, *Standards for Airport Markings*
- AC 150/5360-14, *Access to Airports by Individuals with Disabilities*

B.2 FAA Orders

Below are FAA Orders which provide relevant information or reference information related to planning or designing airport terminal facilities. A directory of all FAA Orders is available at the following location, http://www.faa.gov/airports/resources/publications/orders/.

- Order 5100.38, *Airport Improvement Program (AIP) Handbook*
- Order 5500.1, *Passenger Facility Charge Handbook,*
- Order 5050.4, *National Environmental Policy Act (NEPA) Implementing Instructions for Airport Actions*
- Order 1050.1, *Environmental Impacts: Policies and Procedures*
- Order 6480.4, *Airport Traffic Control Tower Siting Process*
- FAA Order 8260.3, *United States Standard for Terminal Instrument Procedures (TERPS)*

B.3 TRB Reports and Synthesis Documents

Below are TRB (ACRP and TCRP) reports and synthesis documents, which provide relevant information or reference information related to the process of planning or designing airport terminal facilities.

- ACRP 07-15, Airport Terminal Design Electronic Resource Library (PENDING)
- ACRP Report 4, *Ground Access to Major Airports by Public Transportation*
- ACRP Synthesis Report 2, *Airport Aviation Activity Forecasting*

- ACRP Report 10, *Innovations for Airport Terminal Facilities*
- ACRP Synthesis 10, *Airport Sustainability Practices*
- ACRP Report 16, *Guidebook for Managing Small Airports*
- ACRP Report 23, *Airport Passenger-Related Processing Rates Guidebook*
- ACRP Report 25, *Airport Passenger Terminal Planning and Design – Volume 1 Guidebook*
- ACRP Report 25, *Airport Passenger Terminal Planning and Design – Volume 2 Spreadsheet Models and User's Guide*
- ACRP Report 37, *Guidebook for Planning and Implementing Automated People Mover Systems*
- ACRP Report 40, *Airport Curbside and Terminal Area Roadway Operations*
- ACRP Report 52, Wayfinding and Signing Guidelines for Airport Terminals and Landside
- ACRP Report 54, *Resource Manual for Airport In-Terminal Concessions*
- ACRP Synthesis Report 51, *Impacts of Aging Travelers on Airports*
- ACRP Report 55, *Passenger Level of Service and Spatial Planning for Airport Terminals*
- ACRP Synthesis Report 64, Issues Related to Accommodating Animals Traveling Through Airports
- ACRP Report 68, *Guidebook for Evaluating Terminal Renewal Versus Replacement Options*
- ACRP Report 82, *Preparing Peak Period and Operational Profiles—Guidebook*
- ACRP Report 96, *Apron Planning and Design Guidebook*
- ACRP Report 113: *Guidebook on General Aviation Facility Planning*
- ACRP Report 119, *Prototype Airport Sustainability Rating System*
- ACRP Report 130, *Guidebook for Airport Terminal Restroom Planning and Design*
- ACRP Report 142, *Effects of Airline Industry Changes on Small- and Non-Hub Airports*
- ACRP Report 146, *Commercial Ground Transportation at Airports: Best Practices*
- ACRP Synthesis 42, *Integrating Sustainability into Airport Contracts*
- TCRP Report 62, *Effects of TOD on Housing, Parking, and Travel*
- TCRP Report 83, *Strategies for Improving Public Transportation Access to Large Airports*

B.4 Federal Regulations and Guidance

- 14 CFR Part 77 - Safe, Efficient Use, and Preservation Of The Navigable Airspace
- *TSA, Recommended Security Guidelines for Airport Planning, Design and Construction*
- TSA, Planning Guidelines and Design Standards for Checked Baggage Inspection Systems
- U.S. Department of Justice, *2010 ADA Standards for Accessible Design*
- USDOT, Manual on Uniform Traffic Control Devices (MUTCD)

- TSA, Checkpoint Design Guide

B.5 Additional Guidance

Below is a list of additional reference materials and guidance that are mentioned in the previous sections of this AC, which provide specialized guidance or reference information related to the process of planning or designing airport terminal facilities:

- IATA, *Airport Design Reference Manual*
- NFPA 415 Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways
- Airports Council International (ACI), *Apron Markings and Signs Handbook*
- CBP, Airport Technical Design Standards, Passenger Processing Facilities
- ACC, *Guidelines to Selecting Airport Consultants*
- Integrated Security System Standards for Airport Access Control systems, 2008
- Transportation Research Board, *Highway Capacity Manual, 2010*
- Intermodal Ground Access to Airports: A Planning Guide – A Good Start
- *Airport Systems - Planning, Design, and Management*, Richard de Neufville and Amadeo Odoni
- *Planning and Design of Airports*, Robert Horonjeff and Francis McKelvey

Advisory Circular Feedback

If you find an error in this AC, have recommendations for improving it, or have suggestions for new items/subjects to be added, you may let us know by emailing this form to the attention of the Manager of the Airport Planning and Environmental Division (APP-400) via the division website.

Subject: AC 150/5360-13A Date: Click here to enter text.

Please check all appropriate line items:

☐ An error (procedural or typographical) has been noted in paragraph Click here to enter text. on page Click here to enter text..

☐ Recommend paragraph Click here to enter text. on page Click here to enter text. be changed as follows:

Click here to enter text.

☐ In a future change to this AC, please cover the following subject:
(Briefly describe what you want added.)

Click here to enter text.

☐ Other comments:

Click here to enter text.

☐ I would like to discuss the above. Please contact me.

Submitted by: ____ Date: __