Air Cargo Facility Planning and Development—Final Report

DETAILS

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CHAPTER 1: INTRODUCTION—AIR CARGO FACILITIES PLANNING AND DEVELOPMENT

As stated in the original Airport Cooperative Research Program (ACRP) project statement, “The research plan objective of ACRP Project 03-24 is to develop guidelines for air cargo facility planning and development at airports, including collection of necessary data in support of this effort. These guidelines should assist airport operators in crafting effective business policies and development decisions that meet the industry’s current and future technological, operational, and security challenges in a cost-effective, efficient, and environmentally compatible manner. They should also include updated metrics to help guide the overall air cargo development planning process. The potential beneficiaries of these guidelines would include airport owners and operators, airlines, integrated cargo carriers, developers, financial institutions, and others linked to the airport community.”

There have been many studies over the years, at the academic level and professional aviation organizational level, and on-going TRB/ACRP initiatives, to provide planning and design guidance on selected airport issues for airport planning but few solely focused on air cargo facilities. Many studies relate to airport development provide insight into cargo facility development as it applies to the airport planning topic under consideration, such as cargo facilities related to aircraft apron or passenger terminal ramp operations. In fact, while the passenger transport industry has been extensively studied, there is a relative dearth of research specifically on the on-airport air cargo facilities as it relates to airport planning and development. For example, a source outside the U.S. is the International Airport Transport Industry’s (IATA) publication, Airport Development Reference Manual, 10th Edition, (effective December 2014). This document dedicates 38 of 700 pages to air cargo facilities planning. In order to improve the efficiency and financial viability of this industry, further research should focus on a more systematic way for airports to collect and utilize air cargo data. This process could, therefore, lead to more accurate forecasts and ultimately, a more targeted air cargo facility planning process.

The cargo industry has changed significantly over the past 25 years. As the world economy has become more global, markets and manufacturing has developed, shifted and in many instances relocated to markets with low labor rates. New logistics and supply chain concepts developed based on low fuel costs and labor costs along with trends in just-in-time production and final manufacturing assembly at destination. Short shelf life of new products increased during this time period and as the value of goods shipped has increased resulting in increases in the demand for expeditious transport and control as well as transparency. Domestic air cargo in the U.S. also experienced shifts particularly as fuel costs increased within the past five years and integrated express carriers developed deferred delivery business models reducing the demand for overnight delivery by aircraft and relying increasingly on truck networks.

The air cargo terminal is a critical part in the air cargo supply chain. These air cargo installations on airports function as a platform which allow for the interface between land and air modes with the goal of providing the expeditious processing of cargo. This platform has a role to play in ensuring that cargo products arrive at their destination on time and intact, that customers have easy access to the cargo facilities for collection and delivery, and that the truck access is relatively uncongested and does not interfere with passenger related traffic.

This Final Report describes the study’s progress through on-site collection and evaluation of data and the initial structuring of the content of the Guidebook itself. This includes the team’s research, review, and assessment of a variety of previously prepared academic journal articles, and “white papers” that had been funded by the private industry, aviation trade organizations and the Federal Aviation

Administration (FAA) over the years. This Report serves as a summary of the results of ACRP 03-24 research project. This report also provides a glimpse industry trends in terms of its current issues related to air cargo facilities communicated to the research team by industry stakeholders and case study airports who participated in the research project survey and interview efforts. It is important to note that the research efforts led to the development of Spreadsheet Models for Air Cargo Facility Planning and Design.

The following chapters provide, in some detail, the information compiled during Tasks 1 through 10 of the Amplified Work Plan which is included in the appendix of this report. The major components are: The following chapters provide, in some detail, the information compiled throughout the report. The major components are:

CHAPTER 2: TASK 2—LITERATURE REVIEW: AIRPORT AIR CARGO FACILITY PLANNING AND DEVELOPMENT

This chapter focused on two levels of analysis. First, the macro level of airport planning is explored and pertinent literature discussing alternative approaches to airport planning is reviewed. The literature review included over 40 papers, books, articles, and identified current trends and state-of-the-art research in airport strategic planning and airport master planning with a focus on air cargo facility planning and development. The information gathered from the review will be utilized to develop guidelines for air cargo facility planning and development at airports, and for airport operators in making effective business policies and development decisions that meet the industry's challenges. Second, the micro level of airport air cargo facility planning is discussed and the trends which have emerged regarding the process of air cargo facility planning, design, and development; air cargo security, environmental and regulatory issues, and operational and financial considerations are highlighted.

CHAPTER 3: SUBTASK 2.2—LITERATURE REVIEW: REVIEW AND ANALYSIS OF AIR CARGO FACILITY-RELATED AIRPORT MASTER PLANS

Chapter 3 represents a literature review of 12 recent airport master plans published between 2005 and 2011. Focusing on each plan's air cargo elements, the literature review centers on the four components of the air cargo master planning process: air cargo volume forecasts, air cargo aircraft operations forecasts, facility requirements, and recommendations. Further discussion of air cargo volume forecast details the traditional methodologies that involve statistical models and consideration of factors such as the airport's historic air cargo volumes and various trends and forecasts. With an emphasis on innovation, this review highlights the four master plans that used market share approaches or probabilistic forecasting, and a minimal number of airport master plans that used unique approaches to forecasting air cargo aircraft operations.

CHAPTER 4: TASK 1—OVERVIEW OF AIR CARGO INDUSTRY AND TRENDS

Chapter 4 represents an overview of the air cargo industry. It primarily focuses on air cargo activities at airports, facility planning, facility finance and funding, air cargo trends in the U.S., and the culture and staff found within the air cargo industry. Through the collection and detailed analysis of the necessary data, an overview of the state of the air cargo industry was developed to classify its components and identify trends seen in recent years. The overview focused on three components: air cargo carrier activity at airports, air cargo facility development and funding at airports, and air cargo industry trends. Several characteristics and features are outlined for each component. For air cargo carrier activity, the different types of cargo airlines, aircraft, airports, facilities, and buildings found throughout the air cargo industry were identified to provide insight into the functionality of the industry's components. The air cargo facility development and funding overview demonstrates the means by which air facilities are established on airports and the handling systems that operate within them. Lastly, air cargo industry trends at the major air cargo airports were organized in order to explore the relationships that provide the basis for later analyses.

CHAPTER 5: TASK 3—DATA COLLECTION PLAN, FIELDWORK AND INVENTORY PROCESSES

Chapter 5 explains the study data collection plan and implementation. The research team used a two-prong approach in the data collection task. First, the team used a case study approach focusing on select airports representing a range of airport types. Second, a system-wide data collection effort was conducted via an airport management survey. Each effort included collecting samples from a wide variety of airports in the U.S. Surveys were designed and tested with airport participation and air cargo business input. Interviews were held at all case study airports with airport planners and properties managers. This chapter provides details on the data collection plan, fieldwork, and inventory processes.

CHAPTER 6: TASK4—DATA COLLECTION GAP ANALYSIS

Chapter 6 identifies data gaps commonly found in the airport master planning process. It also describes the data gaps the project team experienced during the data collection phase of the project. The team details how data gaps related to specific surveys for this study were remedied through analysis tools provided by Google Earth Pro and other public documentation. In 2012, the research team conducted an intensive survey of air cargo facilities at U.S. airports. The collected data will be used to craft guidelines for air cargo facility planning and development at airports. The primary objective is to assist airport operators in utilizing effective planning practices and in making development decisions that meet the industry's current and future challenges. This chapter concludes with a discussion of efficient techniques to collect data on air cargo activity on airports.

CHAPTER 7: TASK 5—AIR CARGO FORECAST TECHNIQUES

The air cargo industry is faced with some of the most challenging forecast challenges of any industry. Generally, cargo forecasts are undertaken as part of an airports' master planning activity to accommodate facility improvements or in response to unforeseen demand or expectations of the local business community. They are then utilized to assist planners in the identification of appropriate areas for future cargo facility and ramp improvements. Forecasts based on historic trend analysis are increasingly less reliable as future trends cannot be solely based on activities and practices that have evolved into combined modes of both air and truck transport. Over the last two decades, the magnitude and complexity of air cargo forecasting has grown enormously and airport planners are faced with the daunting task of accurately forecasting air cargo tonnage and operations for extensive periods of time. Chapter 7 covers the different approaches and methodologies for forecasting air cargo tonnage and operations. It concludes with a discussion of forecasts utilized in recent air cargo elements of master plans.

CHAPTER 8: TASK 6—AIR CARGO FACILITY REQUIREMENTS

The focus of Chapter 8 is to develop planning metrics and functional relationships that enable a translation from forecasted demand to specific air cargo facility requirements, including elements in response to environmental, sustainability, and security concerns. The analysis describes the rationale behind the facility planning metrics. The scope of work for this chapter sought to link industry trends with their effect on air cargo facilities planning metrics, and to provide an overview of the air cargo industry and recent trends.

CHAPTER 9: TASK 7—PLANNING AND DEVELOPMENT FRAMEWORK

The goal of Chapter 9 is to prepare a planning and development framework that is the basis for forming guidelines used by airport decision makers in planning and developing air cargo facilities. The framework will build on the airport master planning process with a focus specifically on the air cargo facilities and terminal areas. The framework is applicable to a range of airports and facility types based on the existing conditions analysis, environmental concerns, and industry trends. The chapter covers cargo facility layout strategies, a review of forecast techniques, cargo apron strategies, cargo building strategies and facility ratios. The framework is also the basis for the development of an Air Cargo Facilities Planning Model, presented in Chapter 12, which applies cargo facility requirement ratios identified in this chapter.

CHAPTER 10: STRATEGIC DEVELOPMENT PLAN IMPLEMENTATION

Airport planners continually face the challenge of designating land for air cargo facilities, planning for air cargo facilities at their airports, and whether to construct or renovate air cargo facilities when needed. The intent of Chapter 10 is to provide airport planners with the fundamentals of cargo facilities development strategies. These strategies are intended to be applicable to a range of airports and facility types based on current conditions at airports, forecasted change, metrics set forth in the report, and to provide a guideline for development and implementation of a strategic development plan for airports to accommodate air cargo volumes in the future.

CHAPTER 11: TASK 9—VALIDATION PROCESS FOR AIR CARGO FACILITIES PLANNING MODEL AND INSTRUCTIONS

The research team developed an Air Cargo Facilities Planning Model to guide airport planners in the process of determining current and future cargo facility requirements. During the development of the model it was tested by professional airport planners at select U.S. Airports. Airport planners at case study airports were given the opportunity to review the facility planning model and model instructions while a similar opportunity was given to planners at airports unfamiliar with the study and subject matter. Participants were asked to complete a survey to provide inputs on instruction clarity as well as ease of use of the model and its usefulness. Overall respondents are very complementary of the model and two respondents put it to use on existing cargo projects. Relevant comments related to the model and instructions were incorporated into the final draft of the model.

CHAPTER 12: AIR CARGO FACILITIES PLANNING MODEL INSTRUCTIONS

This chapter provides a practical learning tool for airport planners to understand air cargo demand and facility requirements through the Air Cargo Terminal Area Planning Spreadsheet Model. The process flow of the spreadsheet model is to gather data about an air cargo terminal's physical components and determine whether the facilities meet current and forecasted demand. With the inventory in hand, along with the facility ratio matrix determined from survey data and estimation factors, the airport planner can go through the model exercise, starting with the air cargo tonnage and market share inputs, then follow the typical path of current cargo apron, warehouse, trucking facility space for integrated express, passenger carriers and all-cargo carriers/third party handlers. This exercise is intended to provide understanding as to why airport planners use certain cargo related ratios and planning factors; it is not intended as a "one-size-fits-all" guidebook of specific metrics for facility demand requirements. The model was developed with the goal to enhance learning and providing a starting point for the airport planner in the air cargo facility requirements analysis.

CHAPTER 2: LITERATURE REVIEW—AIRPORT AIR CARGO FACILITY PLANNING AND DEVELOPMENT

CHAPTER OVERVIEW

This literature review identifies current trends and state-of-the-art research in airport strategic planning and airport master planning with a focus on air cargo facility planning and development. Through this review, several themes emerged which will dictate the direction of future research trends in this field. First, the process used in airport strategic planning and master planning in the U.S. and internationally has been criticized by leading academicians for lacking the flexibility and adaptability required to deal with the uncertainties at airports, which has led to significant over- or under-estimating aviation activity which has in turn lead to over- or under-building airport facilities. Several alternative airport strategic planning and master planning approaches have been developed and further research is required in this area to ensure that future airport facilities are better able to meet future aviation needs. Second, rapidly changing regulations in aviation security and environmental sustainability, in addition to changes in technology, commodity types, and demand have resulted in rapid changes in the air cargo industry, underscoring the need for flexibility and adaptability in air cargo facility planning. Third, while the passenger transport industry has been extensively studied, there is a relative dearth of research specifically on the air cargo industry as it relates to airport planning and development. In order to improve the efficiency and financial viability of this industry, further research should focus on a more systematic way for airports to collect and utilize air cargo data. This process could, therefore, lead to more accurate forecasts and ultimately, a more targeted air cargo facility planning process.

INTRODUCTION

This literature review was conducted as part of the effort to identify current trends and state-of-the-art research in airport strategic planning and airport master planning with a focus on air cargo facility planning and development. This information will be utilized to develop guidelines for air cargo facility planning and development at airports. These guidelines will assist airport operators in making effective business policies and development decisions that meet the industry's current and future technological, operational, and security challenges in a cost-effective, efficient, and environmentally sustainable manner.

As part of the Literature Review, over 40 papers, books, and articles were reviewed. This paper extracts the major trends in air cargo facility planning and development which emerged from the literature review, focusing on two levels of analysis. First, the macro level of airport planning is explored and pertinent literature which discusses alternative approaches to airport planning is reviewed. Second, the micro level of airport air cargo facility planning is discussed and the trends which have emerged regarding airport the process of air cargo facility planning, design, and development; air cargo security; environmental and regulatory issues; and operational and financial considerations are highlighted.

AIRPORT PLANNING PROCESS

Airport Master Planning (AMP) is the process in which a Master Plan is developed for the airport which identifies the short-, medium-, and long-term development plans for the airport. Table 2-1 provides an overview of study objectives and the major findings of the airport planning literature that was reviewed which addressed the process and techniques of airport strategic planning and master planning. In the U.S., the FAA has developed guidelines for the master planning process which involves a specific formalized process as detailed in the FAA's Advisory Circular 150/5070-6B, Airport Master Plans, May 1, 2007. Internationally, airport planners utilize manuals by the International Civil Aviation Organization (ICAO), as well as books and journal articles about airport planning by leading academicians and practitioners. In general, the guidelines used by the FAA, the ICAO, and the International Air Transport Association (IATA) are fundamentally the same (IATA, 2004; ICAO, 1987; de Neufville and Odoni, 2003). The primary focus in an AMP is often on the development of the plans rather than the decision-making process. The key steps in the AMP process are:

- Identify existing conditions;
- Develop aviation forecasts;
- Determine facility requirements;
- Develop and evaluate alternatives;
- Develop the best development alternative into a detailed Master Plan; and
- Present the findings in a report and Airport Layout Plan (ALP).

The AMP approach has come under increasing criticism by academicians and practitioners alike because it is not able to deal with the many future uncertainties inherent with airports. The primary method that uncertainty is handled in AMPs is through aviation demand forecasting. Aviation demand forecasts can include projections for the number of passengers, tons of goods shipped, or number of air transport movements. In the AMP, the forecasts are compared with the existing conditions at an airport, and a determination is made about whether there will be a need for new or expanded facilities. Thus, forecasting directly determines the proposed airport development included in Master Plans. Forecasting has come under increasing criticism, however, because of its potential to under- or over-estimate demand, which can lead to airports either over-building or under-building their facilities. Kwakkel, Walker and Marchau (2010) found that forecasts fail as a result of either forecaster bias or uncertainty. Forecaster bias can occur if forecasters have an inherent desire to make the project appear as favorable as possible due to a political agenda or because the forecaster is a promoter of the project. Uncertainty can result in forecasting failure if forecasters use faulty assumptions to make their forecasts or fail to take into account economic, public policy or political factors that can affect forecasts. The increased privatization of the aviation industry, increased competition between airports to attract carriers, and the increased volatility in air traffic demand have been cited as factors leading to increased uncertainty in forecasting. (Kwakkel, Walker, and Marchau, 2010) In addition to the uncertainties that make aviation demand forecasting highly problematic, Kwakkel et al. (2010) indicated that aviation demand forecasting often relies on only a single demand forecast, which increases the likelihood of severely underestimating the range within which future aviation demand might develop. In addition to uncertainties inherent in forecasting, there are other uncertainties that are present in developing plans for long-term development at an airport. These uncertainties include regulatory changes, technological developments, and demographic changes (Kwakkel et al., 2010).

Table 2-1 Literature Summary – Airport Strategic Planning and Master Planning.

Study	Study Objective	Major Findings
Burghouwt (2007)	Explores what the consequences of a deregulated EU air transport market are for Airline network development and airport planning.	Deregulation has led to changes in the way airlines organize their networks and how airport authorities plan their infrastructure.
Burghouwt (2003)	Addresses the change in European aviation and the consequences for airline network behavior and describes the new context in which airport planners operate.	Airport planning must be flexible in order to cope with a highly unstable market. More research is required to determine what extent European airport authorities have already adopted flexible planning approaches.
De Neufville (2001)	Explores long-term prospects for airport development into the 21st century.	Substantial changes in the years ahead in terms of the level of traffic, its distribution across the country and business sectors, the physical configuration of airports, and their management and way of doing business make it imperative that airport planners utilize a modular, flexible approach to airport systems planning and design.
De Neufville (2003)	Explains the integration of "real options" analysis in the design of public and private systems and how it will change the way planners deal with uncertainty and risk.	Use of "real options" will lead planners to account for fluctuations in the market; understand that uncertainty is not always a risk to be avoided but can present an opportunity to be exploited; adopt a proactive stance toward risk; introduce flexibility into design of systems.
De Neufville and Odoni (2003)	This book covers the development and management aspects of airports using a dynamic strategic planning (DSP) approach.	The success of airports depends on its advantages compared with other airports. DSP is an approach which enables airports to respond flexibly to uncertain future conditions.
Karlsson (2003)	Explores how airport at Pease International Tradeport utilizes DSP.	Even when the need for DSP is evident, it can be difficult for airport planners to know how to apply it in practice. Tools such as decisions analysis and options analysis should be used to ensure that the benefits exceed the costs.
Kwakkel (2007)	Discusses the challenge of how to deal with uncertainty in Airport Strategic Planning (ASP).	AMP and ASP have proven insufficient for handling the uncertainties airport face. Finding new ways to deal with uncertainties surrounding the future is a key issue in air transport research.
Van Leeuwen, Oei, Buzing, and Witteveen (2007)	Explains the methods of alleviating congestion at peak hour operations.	To alleviate this aircraft turn bottlenecks, robustness of the planning of these activities is of paramount importance. The paper presents a new idea to solve a strategic planning problem in a way that allows unforeseen, real-time disruptions to be handled in a straightforward and elegant manner. To that end the authors apply Hunsberger's decoupling algorithm to a Simple Temporal Network representation of the ground handling domain.
Kwakkel (2008)	Explains how DSP and Adaptive Policymaking (APM) would have resulted in more robust outcomes that the traditional master planning process Schiphol Airport.	Both DSP and APM have a broader perspective on uncertainty than AMP; they look at other factors that could interfere with the success of the plan, in addition to demand uncertainties. Both APM and DSP, instead of predicting what will happen, let part of the uncertainty resolve itself over time and take the necessary actions based on how events unfold.
Kwakkel et al. (2010)	Examines three adaptive alternatives to AMP: DSP; APM; and Flexible Strategic Planning (FSP) and presents a synthesized approach called Adaptive Airport Strategic Planning (AASP).	AASP is a stepwise approach which incorporates pro-active actions that aim at seizing opportunities and taking actions to protect the plan against vulnerabilities.

SOURCE: CDM Smith.

These uncertainties can lead to failure in AMP. Amsterdam's Airport Schiphol is an example of AMP failing. A Master Plan completed for this airport in 1995 recommended improvements that would accommodate the forecasted increase in commercial service for the planning period from 1995 to 2015. Due to a significant underestimation of demand, however, the airport was not able to accommodate the increased air traffic without exceeding the allowable noise levels, leading to a temporary shutdown of the airport in 1999. In addition, the passenger limit for the airport was reached in 2005, fifteen years before the end of the 20-year planning period. Other AMP failures include Denver International Airport, Boston Logan Airport, and the Montreal Mirabel Airport (Kwakkel et al., 2010).

Several alternative planning approaches have recently emerged that may be better able to deal with these uncertainties. Two alternative approaches to Airport Master Planning include: the Dynamic Strategic Planning (DSP) approach and the Adaptive Policy Approach (APA) (Karlsson, 2003; Kwakkel, 2008). DSP is an approach for making flexible plans that can be easily adjusted over time to the actual situation and conditions. The resulting dynamic strategic plan defines a flexible development over several stages; it commits only to a first stage, and then proposes different developments in the second and subsequent stages. DSP allows for flexibility to be built into the plan to make it possible to deal with a range of futures. Although outside the DSP process, Van Leeuwen addressed targeted facility planning to meet peak hour demand (Van Leeuwen et al 2007).

Adaptive Policymaking (APM) is an approach for planning under severe uncertainty. It recognizes that in a rapidly changing world, fixed, static policies are likely to fail. An adaptive policy is designed to be incremental, adaptive, and conditional. The APM process is split into two phases: a thinking phase, during which the adaptive policy is developed, and an implementation phase, during which the policy is implemented and the policy adapted, if necessary. Mitigating actions could be developed for vulnerabilities identified during the thinking phase and for uncertain vulnerabilities hedging actions could be taken to make the basic policy more adaptive. Adaptive flexible approaches to airport strategic planning appear to be better equipped to deal with the many uncertainties that airports face. There is not yet a single clear flexible approach that is directly applicable to airport planning. Both APM and DSP are still relatively conceptual, and it might be possible to combine the ideas from both into a single adaptive approach to Airport Strategic Planning (ASP) (Kwakkel, 2008). In a follow-up paper, Kwakkel et al. (2010) further explored the development of an alternative planning approach for long-term development. This paper identified four criteria that the alternative planning approach should meet to enable it to deal better with uncertainties faced by airports. These criteria include:

- The planning approach should consider many different types of uncertainties, in addition to demand uncertainties;
- The planning approach should consider many different plausible futures;
- The resulting plan should be robust across the different futures; and
- The resulting plan should be flexible (Kwakkel et al., 2010).

In addition to the DSP and APM, Flexible Strategic Planning (FSP) has been suggested as an alternative to traditional AMP by Burghouwt (2007). FSP has many similarities with DSP but includes the concept of proactive planning on the part of the airport. In order to have a flexible strategic plan for an airport, FSP relies on real options, flexibility in planning scenarios, contingency planning, monitoring, experimentation, and diversification. Kwakkel et al. (2010) presents a comparison of the three approaches for adaptive planning and presents the design for an improved approach for Airport System Planning (ASP) by combining the strengths of the different approaches. The new approach, which is called Adaptive Airport Strategic Planning (AASP) includes the following steps:

- Step 1: Stage Setting – Analyze the existing conditions of an airport, specifying project objectives, constraints, and available policy options.
- Step 2: Assembling the Basic Policy – Specify the basic policy and identifying the conditions necessary for the policy to succeed.
- Step 3: Robustness – Identify vulnerabilities and opportunities associated with the basic policy and specifying actions to take in anticipation or response to them. These actions include mitigating actions, hedging actions, seizing actions, and shaping actions.
- Step 4: Contingency Planning – Expand the policy via contingency planning, in which the basic policy is further enhanced by including adaptive elements. Critical values (triggers) of variables (signposts) are identified beyond which actions should be implemented to ensure that a policy keeps moving in the right direction and at the proper speed. Demand is one variable that should be monitored and actions can be taken to ensure that changes in the plan occur as demand changes.
- Step 5: Implementation - Actions to be taken immediately are implemented and a monitoring system (from Step 4) is established. Signpost information related to triggers is collected, policy actions are started, altered, stopped, or expanded.

A method of testing a new planning approach and comparing its performance with the traditional Airport Master Planning approach needs to be developed before a new approach is adapted. This area is recommended for subsequent research (Kwakkel, 2008).

AIRPORT AIR CARGO FACILITY PLANNING AND DESIGN PROCESS

The Literature Review included a review of research pertaining to best practices, recent innovations, and future trends specifically in airport air cargo facility planning and design. The literature review, which is summarized in Table 2-2, focused on the following key topics related to airport air cargo:

- Air cargo facility design standards
- Land use and access requirements
- Financial considerations and operational issues
- Security
- Environmental issues

Table 2-2 Literature Summary—Air Cargo Facility Planning and Design Process.

Study	Study Objective	Major Findings
Air Cargo Facility Design Standards		
Ashford et al. (2011)	This chapter presents the elements to be considered in design of air freight terminals.	Design of cargo facilities should provide a large degree of flexibility due to ongoing changes in traffic and technology.
Ballis (2007)	This paper presents an overview of airport cargo facility design and describes analytical methods used in various air cargo terminal design aspects.	The sizing and planning of the air freight terminal should take into account many design parameters, starting from the specific requirements of its users and market demand forecasts and seasonal, daily, and hourly fluctuation estimations, followed by a systematic terminal operation analysis that may be performed by analytical methods or by simulation.
Biggs (2009)	This report provides methods and data required to conduct user surveys at airports. Chapter 10, Cargo Surveys, focuses on typical target populations for air cargo, such as air cargo operators and freight forwarders, and key factors relevant to cargo surveys.	Air cargo surveys may be required when the available data sources do not provide the level of information needed for air cargo facility planning. Waybill data are a superior data source for analysis, but freight forwarding companies are reluctant to provide this information.
Kazda and Caves (2007)	The author provides an overview of air cargo, including requirements for air cargo terminal design. DHL is presented as a case study in how they planned their cargo facility.	There are numerous factors which dictate the size of air cargo terminals including the amount of freight delivered at one time, the expected dwell time, the density of the freight, the size of equipment, the degree of automation, and the role of the terminal. Due to continual changes in the way air cargo is handled, flexibility in facility planning is critical.
Chen and Chou (2006)	This article proposes a novel procedure for designing air cargo terminals, based on the balanced scorecard (BSC) methodology, and applies this procedure in a case study of air cargo terminals.	The BSC methodology involves employees, shareholders, and customers. The BSC framework can be used to identify financial, customer, and internal process design requirements for air cargo terminals. Key performance indicators that are important in designing terminals include: the availability and efficiency of material-handling equipment, the utilization and turnover rate of the storage positions and space, and the process operating efficiency.

Table 2-2 (*continued*) **Literature Summary—Air Cargo Facility Planning and Design Process.**

Study	Study Objective	Major Findings
Puget Sound Regional Council and Landrum & Brown (2006)	This study reviewed the ability of the Puget Sound Region to handle air cargo and to determine how the regional air system can be best utilized to address air cargo needs over the next 20 years.	Planning for air cargo should take into account regional goals and strategies that can function with the separate airport and industry management structures that currently exist.
Land Use and Access Requirements		
Frawley et al. (2011)	The purpose of this study was to identify challenges and solutions to providing landside freight access to airports.	Good planning and coordination among involved agencies lead to the best landside freight access to airports. Wayfinding and proper roadway design are vital elements of good landside freight access to airports.
Frawley et al. (2011)	This research report identifies the issues, barriers, physical bottlenecks (e.g., infrastructure needs), and solutions (including funding mechanisms) concerning landside access to airports in Texas.	Key characteristics in providing good landside freight access to airports include wayfinding, signage, and minimizing the comingling of freight and passenger traffic in areas near the passenger terminals. A variety of funding opportunities exist through public, private, and shared sources to improve access to airports.
Financial Considerations		
Golicic, S.L. et al. (2003)	This paper describes the use of a market opportunity analysis (MOA) to gauge the feasibility of smaller airports expanding their air cargo operations.	This analysis suggests that MOAs will reduce risks and more successfully target marketing and planning efforts.
Hertwig and Rau (2010)	This book presents an overview of the air cargo industry, available risk management theories and practices, and their applications.	Capacity options and financial intermediation are presented as more innovative approaches for capacity risk management. Obstacles to successful implementation of risk management methods are identified and potential solutions discussed.
Operational Issues		
Fok et al. (2004)	This paper describes the authors work in using mathematical optimization to assist air cargo load planning for one of the world's top 10 air cargo carriers.	Using the Cargo Load Plan and Analysis System (CLPA), a Web-based application for air cargo load analysis and planning, the authors were able to develop an optimized plan within less than one minute.

Table 2-2 (*continued*) **Literature Summary—Air Cargo Facility Planning and Design Process.**

Study	Study Objective	Major Findings
Operational Issues		
Kiso and Deljanin (2009)	This paper examines the airfreight sector in terms of its structure, organization, its role in the supply chains, its constraints and future prospects.	The emphasis on multimodal transport operations and on greater integration of transport with other logistical services will dominate freight developments in the next two decades.
Petersen (2007)	This paper presents a macro-overview of the state of the air cargo industry and a comprehensive summary of how each component along the air cargo supply chain works. Challenges faced by the industry and areas for future research also are provided.	The author recommends further research in the following areas: studying the planning process of the cargo network; developing air cargo revenue management; developing a better understanding for collaboration along the air cargo supply chain; and designing more efficient warehouse and ground handling systems.
Security Considerations		
Buzdugan, Maria (2005)	This thesis presents an overview of the potential risks and best security practices identified within several international, regional and national initiatives, including the "authorized economic operator" and "secure supply chain" mechanisms.	An internationally agreed approach is necessary in order to adequately respond to the international nature of air cargo security risks. It will most likely take years to establish and properly implement adequate international standards and install the required monitoring systems. Central management and integrity in implementation is critical to ensuring the success of a uniform air cargo security system.
Department of Homeland Security, Office of Inspector General (2009)	This report addresses the effectiveness of the Transportation Security Administration's (TSA) efforts to secure air cargo while it is handled or transported on the ground, before being shipped on passenger aircraft.	The report made six recommendations to the TSA that, when implemented, would strengthen the security of air cargo during ground transportation.
Elias (2005)	This paper summarizes the security-related findings and recommendations of the 9/11 Commission, which included vulnerabilities in air cargo.	The 9/11 Commission issued several recommendations designed to strengthen aviation security including intensifying efforts to identify, track, and screen potentially dangerous cargo and deploying hardened cargo containers on passenger aircraft.

SOURCE: CDM Smith.

Air Cargo Facility Design Standards

Business trends over the past two decades have resulted in an increase in air cargo demand. Efficient inventory management requires 'just- in- time' manufacturing or quick response to consumer needs. There is also increased use of global outsourcing. Manufacturing and product fulfillment supply chains need to be agile to change the type, volume, and mix of products in short time frames. Consequently, air cargo represents an increasingly significant share and value of the transport market. In addition to mail, express, and emergency cargoes, air transportation is being used for perishable commodities, such as seafood, flowers, pharmaceuticals, and just-in-time deliveries. The following issues related to airport air cargo facility planning and design were identified during the literature review:

There is a need for airport planning practitioners to better understand methods for conducting specific air cargo planning studies and collecting air cargo data. Air cargo activity requires dedicated air cargo terminals, warehouses, and apron facilities on airports, in addition to dedicated road systems. Biggs (2009) stresses the importance in collecting air cargo data in order to prepare forecasts required to determine future airport facility requirements and to ensure the sufficiency of the roadways for the resulting truck traffic, both on airport and connecting to major highways throughout the region. Air cargo data that are required for air cargo forecasting includes the following:

- Weight or volume of cargo and mail
- Ultimate origin and destination
- Times at origin and destination
- Commodity type or value
- Flight information
- Truck trip characteristics

While this information is available on air cargo waybills, it is highly valued by the shippers and forwarders, guarded by privacy rules, and not released easily. One data source is the Cargo Network Services Corporation, which provides air cargo waybill data for a fee. Other data sources that may be available include municipal and state agencies that conduct truck surveys and interviews. In addition, there are an increasing number of automated truck pseudo-tracking systems, such as the I-75/AVION system which utilize intelligent tags that track trucks and their contents along a corridor.

If these data sources are not available, airport facility planners may need to collect data through a survey. With the increasing importance of access to air cargo in the world economy, there is a need to improve research in the conduct of air cargo studies and the collection of air cargo data to provide input into air cargo facilities planning and development. *ACRP Report 26: Guidebook for Conducting Airport User Surveys* provides a brief chapter on collecting cargo related data. To date, the most common survey method for air cargo is similar to stakeholder interviews. Although shippers and forwarders may be reluctant to release detailed information on air cargo shipments, or air cargo traffic and commodity type at their facility, it is possible to construct a survey in the form of an interview. As an alternative method, it may be possible to conduct truck driver interviews at a roadside location near the cargo facility. This survey method was adopted for an extensive survey performed at Toronto Pearson International Airport in 2005.

In general, there is a relative lack of information regarding the design of these facilities where flexibility is essential. The most accurate design process is likely to be developed by utilizing information regarding the mix and flow characteristics of the cargo, the predicted aircraft fleet mix, handling practice, and surface transport characteristics. Even when simulation software is utilized to design the facility, it often can be a misleading process and can to lead to significantly incorrect conclusions when unforeseen events occur, such as changes in technology, commodity types or handling procedures. Ashford et al. (2011) provide design criteria for a freight terminal based on an estimated amount of cargo processed per month. Utilizing formulas, design requirements are calculated for total area, landside truck doors, build-up/breakdown positions, pallet staging rack, bins, and bypass doors. For master planning, less rigorous methods of cargo terminal sizing are often used, with the overall area computed from annual tonnage throughout. For the foreseeable future, it is recommended by Ashford that the design of air cargo facilities should provide a large degree of flexibility to account for uncertainty in demand and technology (Ashford et al., 2011).

Ashford et al. (2011) and Puget Sound Regional Council et al. (2006) identified the changes in technology, commodity types, and demand which have resulted in rapid changes to the air cargo industry. These changes include the following:

- *Diverse Containers* – The freight industry has undergone a conversion to the use of unitized loads which range in size and capacity and now include refrigerated units (containerization).
- *Demand for High-Speed Logistics* – The changes in manufacturing and shipping are resulting in the creation of new high-speed logistics facilities that can effectively integrate the transport and production segments of industries. The facilities can handle throughput and sortation, kitting (minor assembly), and returns, as well as traditional operations. These buildings are of multi-story design, and can be situated on the airport, including adjacent to the aircraft apron to further reduce handling costs and conserve space. These facilities can also be located off-airport.
- *E-commerce* – E-commerce is a growing market segment that increases the demand for air cargo, particularly integrated carriers, and is expected to do so in the future because they require overnight delivery. However, an increase in second- and third-day delivery will limit the growth in overnight deliveries. The Forrester Group, a transportation research organization, and many manufacturers estimate that about seven percent of internet purchases are returned, creating reverse logistics demand in air cargo (Forrester, 2008).
- *Aircraft Technology* – There has been a rapid and widespread introduction and adoption of wide-bodied aircraft capable of accepting large unit load devices (ULDs). In addition, modern freighters are more fuel efficient and have a greater range. These aircraft include B777F, B747-8F, and B787 Dreamliner Passenger Aircraft. The development of the Airbus A380 will affect international gateway airports' runway and taxiway systems and passenger terminals. Airbus has not yet developed a freighter version of the aircraft.
- *Increase in Air Passengers* – According to the 2011 Boeing Current Market Outlook, global forecasts indicate that the world passenger market will more than double over the next twenty years. In order to meet passenger demands, there will be pressure on airports to make changes to how they handle air cargo.
- *Increase in Trucking* – Trucking has also grown as an important component of air cargo transport. Many air cargo facilities operate as truck terminals yet there have been few requirements to report truck-to-truck traffic at airports. Information regarding truck-to-truck traffic needs to be better collected to enable airports to plan for new development. In addition, airports must address the fact that an air cargo facility is an inter-modal facility, and must be designed to accommodate trucking, or see that some of this activity is relocated off-airport.
- *Increase in Integrated Carriers* – The trend toward integrated carriers will continue, combining air with truck, rail, and sea transport.

- *Use of Electronic Data Interchange (EDI)* – With the use of EDI, the communication, tracking, and tracing of documents by the shippers has been facilitated and much of the paper trail has been eliminated. Also, most consignments can be cleared through customs before arrival.
- *Building Technology* – As a result of the rising cost of maintaining inventory and the shortage of on-airport property at some airports, modern cargo facilities are being designed to emphasize speed of transition rather than warehousing. Cargo buildings are now taller to handle highly mechanized equipment with sufficient depth and adequate airside and landside doors. New proposals include multi-level facilities to minimize the facilities' ground footprint such as Hong Kong Air Cargo Terminals Limited (HACTL) and British Airways cargo terminal at London Heathrow.
- *Security Changes* – Since 9/11 there has been an accelerated shift to the use of freighters. In addition, there have been numerous security changes in the industry to implement anti-terrorism requirements. These changes include restrictions of the "known shipper" rule which have made it more difficult for shippers and forwarders to utilize different business partners and grow their business. Forwarders now hold shipments as long as they can before a flight, resulting in a large number of trucks arriving at the airport in a two- or three-hour time frame. At some airports, cargo complexes now have separate parking areas for trucks and cars and many perform checks of the driver and cargo manifest at the cargo area entrance. There has been the development of several operating guidelines and technological innovations that have made air cargo facilities more secure. In addition, personal and vehicle access to the aircraft operating area is continuously being examined and limitations on who is eligible for access is in flux. Changes in these policies would affect several of the integrated carriers. Security issues and trends are further discussed in the "Security" section of this paper.

The air cargo industry has undergone a period of rapid growth, which has slowed down recently with the economic recession. However, air cargo remains a highly dynamic industry and individual airports' demand variations can be dramatic. Therefore, the design and development of air cargo facilities should be flexible to take into account any modifications of design parameters due to changes in demand and technology.

Air Cargo Related Land Use and Access Requirements

Several studies have been conducted to investigate issues related to landside freight access to airports. These studies included two conducted by William Frawley et al. for the Texas Transportation Institute, Texas Department of Transportation, and Federal Highway Administration (FHWA) which identified the issues, barriers, infrastructure needs, and solutions concerning landside freight access to airports (Frawley, 2011). The major issues that were identified and the possible solutions presented include in Table 2-3.

Table 2-3 Landside Freight Access to Airports—Issues and Solutions.

Issue	Solution
System/Roadway Design: Roads in the vicinity of airports need to be designed for large trucks, including requisite turn radii at driveway and highway intersections.	Airport authorities and local transportation agencies need to consider truck-specific issues when planning airport roadways.
Traffic: Problems occur when airport access roads have numerous intersections, entrances, and exits and traffic weaves among lanes to enter and exit the access roads.	During airport planning and design, exits, entrances, and other intersections should be designed to take into account truck traffic and minimize the comingling of truck and automobile traffic. In addition, signage along the access road should provide the clearest access routing to freight areas.
Wayfinding: Truck drivers may be unfamiliar with routes to an airport. Therefore, good signage is necessary to provide accurate directions with enough advance notice to allow drivers to make lane changes in advance of exits and intersections.	Solution: Signage should be in place to direct freight traffic to air cargo areas so that trucks do not mix with passenger traffic.
Adjacent land uses along connector roads: Significant truck volumes can pose problems on roads with frequent intersections, especially those used by pedestrians. Older, inner city airports have road connections to access-controlled highways that are typically abutted by a variety of land uses, including residential, retail, office, industrial, and hotel. The primary obstacle to improving compatibility of land use with truck traffic near airports is the inability to manage the existing land uses along the approaching roadways. Another obstacle is often the lack of adequate alternative truck routes.	One solution to this problem is to designate truck routes along certain roads and to prohibit truck traffic on others.
Traffic Control: High levels of unprotected left turns by trucks at intersections between airport-grounds driveways and arterials on the surrounding roadway network can create serious traffic problems.	Truck-specific traffic issues should be addressed during the planning stage for the airport
Cargo Facility Site Location: The location of freight facilities at an airport may face competing interests. Issues relating to site selection for a freight center may include land availability on airport property, surrounding land uses, and the provision of safe and efficient landside access. In addition, as freight activity and truck volumes increase, truck queues and storage can pose a challenge.	Coordination with transportation planning agencies should be undertaken to identify which roads may realistically be improved or extended to serve freight traffic in specific areas. Roadway characteristics to be considered include intersection geometrics, lane widths, requirement for turns across traffic lanes, and pavement structure. Airports that have limited on-site land may consider smaller facilities on the airport property and encourage shippers to use larger facilities at nearby off-airport locations.

SOURCE: Frawley, 211.

Financial/Operational Considerations

The air cargo industry has had poor financial performance over the past five years. When cargo carriers perform poorly financially it may ultimately affect airport revenues with decreases in landing fees as frequency of operations and tonnages decline. Carriers may also cease operations at an airport and terminate lease agreements.

Although recent trends indicate productivity and efficiency have been increasing, these positive gains have been negated by sudden increases in operating costs, especially fuel and increasing security costs. In addition, anti-trust fines have hit some carriers at a time when they are not in strong position to pay them. The airlines have also not been able to be as reactive to business cycles and many have expanded capacity too quickly on the upswing of the cycle and cut capacity back too slowly during the downturns. Some cargo airlines have adopted new strategies to improve their profitability. One example is Singapore Airlines (SIA) which has introduced greater flexibility into its freighter schedule to take into account the fact that off-peak traffic was often 20% or so below peak levels. By reducing freighter capacity in the off-peak the airline could use the freed-up capacity for charters.

Another strategy that has been employed to improve cargo carrier financial performance has been the utilization of software programs to improve Cargo Revenue Management (CRM) in order to achieve the best rate and density mix of shipments and, therefore, to maximize revenue on each flight. In order to do this it is necessary to forecast the demand at different rates by day for each flight segment up to the time of departure. Sabre of the U.S. has developed the 'AirVision Cargo Revenue Manager,' previously known as CargoMax. Its key functions are:

- Provides key flight, customer, and booking information;
- Forecasts available cargo capacity by market, segment, and equipment type;
  Day of week; and time of day to help accurately plan cargo loads for maximum revenue;
- Ensures acceptance of higher yield shipments through optimal allotment of cargo space to stations or agents and online profitability evaluation;
- Increases productivity and supports superior decision-making by supplying efficient data analyses via management reports and performance-monitoring tools;
- Identifies revenue streams and potential service failures proactively through interactive flight-monitoring capabilities to improve earnings and service quality; and
- Considers booking behavior during optimal overbooking of cargo capacity to capture additional revenue and reduce offloads.

Petersen (2007) describes KLM's revenue management system which utilizes a "margin management" system to optimize the margin of cargo by a) increasing revenues b) decreasing the network costs for handling and c) enhancing load factors in both volume and weight. Fok et al. (2004) also developed a Cargo Load Plan and Analysis System (CLPA), a mathematical optimization system which assists in air cargo load planning. This system, when used by one of the world's top 10 air cargo carriers, was able to develop an optimized loading plan within one minute. These programs show promise in improving the efficiency of air cargo companies thereby, increasing their financial performance. More research should be done in this area to improve the comprehensiveness of these systems (Morrell, 2011; Petersen, 2007).

Security

Air cargo security issues affect airline operations and the airport facilities utilized by air cargo carriers. Cargo screening is now mandated for all cargo loaded onto passenger aircraft. These mandates require refitting cargo facilities at airports to accommodate screening equipment and personnel. This section addresses the policies and outcomes of air cargo screening for air cargo transport.

Air Cargo Security Related to Passenger Aircraft – In the U.S., the Transportation Security Administration (TSA) is responsible for transport security, which includes air cargo. The legislation that mandates the air cargo security regulations is the *Implementing the 9/11 Commission Recommendations Act of 2007,* also known as the 9/11 Act. The Act directed the Secretary of Homeland Security to establish a system to enable industry to screen 100% of cargo transported on passenger aircraft at a level of security commensurate with the level of security of passenger checked baggage within three years. The legislation set interim milestones for the industry to screen 50% of all cargo shipped on a passenger aircraft within 18 months of enactment, by February 2009 and 100% screening by August 2010.

TSA implemented three programs to meet the air cargo screening goals. The first, narrow-body aircraft screening became effective in 2008. This program required that all cargo on narrow-body aircraft must be 100% screened individually before it is netted, containerized, or shrink-wrapped. The second, the Certified Cargo Screening Program (CCSP), allows freight forwarders and shippers to pre-screen cargo. The CCSP allows freight forwarders and shippers to pre-screen cargo, which can be cost-prohibitive for smaller forwarder and shipper firms since scanning equipment can cost between $30,000 and $100,000 (Morrell, 2011). The third program was international collaboration. International collaboration has been initiated with the European Union (EU), Canada, and Australia. By mid-2010 almost all domestic and outbound U.S. cargo on passenger services complied with the Act. TSA is working with international air cargo operators to increase their share of cargo placed on passenger flights that is screened, but 100% screening may not be achieved until August 2013. In the interim, TSA, along with Customs and Border Protection (CBP) and international partners, is utilizing risk-based targeting to increase screening of air cargo. Among the risk-based strategies that are being utilized is the Known Shipper Program. This program established an industry-wide Known Shipper Database (KSDB) for vetting all shipments placed on passenger aircraft. Shipments from parties that do not appear on the database may not be placed aboard passenger aircraft, even if they are screened or inspected physically. This applies to inbound international, as well as domestic flights.

Air Cargo Security Related to Freighters – There are currently no statutory or regulatory requirements for screening all-cargo operations. According to industry estimates, the overall percentage of international shipments screened before transport to the U.S. may be as low as 50%. Screening international cargo has several impediments including: shippers' limited control over their foreign supply chains, the scale and diversity of worldwide supply chains, and diplomatic considerations. In October 2010, two explosive devices being prepared for loading on U.S. bound all-cargo aircraft overseas were found. These incidents heightened concerns over the potential use of air cargo shipments as weapons to attack ground targets and renewed interest requiring that all air cargo, not just the cargo placed on passenger aircraft, be subject to physical screening. New legislation was introduced in both the House and Senate in 2010 that required screening of all cargo transported on all-cargo aircraft, including U.S.-bound international shipments, in a manner similar to the screening requirements for passenger checked baggage. The legislation also included provisions requiring inspections of foreign air cargo shipping facilities that handle U.S.-bound flights and formal security training programs for cargo handlers (H.R. 6410, 111th Congress and S. 3954, 111th Congress). While neither bill was enacted, this issue has not gone away (Elias, 2010).

The ICAO and the World Customs Organization (WCO) recently signed a Memorandum of Understanding (MOU) for increased cooperation to protect air cargo from acts of terrorism or other criminal activity and for speeding up the movement of goods by air worldwide. Cooperation between the two organizations is focused on developing electronic advance data, information sharing and exploring the application of risk management to cargo for identifying threats and implementing the required security measures, including the vetting of advance-cargo information. More stringent ICAO standards concerning air cargo were enacted on July 1, 2011, which include a new requirement for Member States to establish a supply-chain security process (*ICAO and WCO Join Forces to Strengthen Air Cargo Security*, 2011).

In the U.S. and internationally, the air cargo industry is moving toward requiring greater security measures, which will continue to present economic challenges. If 100% screening were to be required, the economic impact would be considerable. The projected cost of physically screening all air cargo could conceivably total several billion dollars annually. While some of the associated costs may be passed on to shipping customers, many costs will likely be borne by the air cargo industry. In addition, the logistical challenges of screening all air cargo may be significant, resulting in shipping delays and other inefficiencies.

The following issues were identified (Elias, 2005) for the Congressional Research Service, as possible areas that may be explored by Congress in the near future regarding air cargo security:

- The desirability of risk-based strategies as alternatives to 100% cargo screening and inspection;
- The adequacy of off-airport screening under the CCSP in conjunction with various supply chain and air cargo facility security measures;
- The costs and benefits of requiring blast resistant cargo containers to protect aircraft from in-flight explosions in cargo holds;
- The desirability of having air cargo screened by employees of private firms rather than TSA and CBP employees; and
- Cooperative efforts with international partners and stakeholders to improve the security of international air cargo operations.

Environmental

Many air cargo operators are implementing technological and operational changes to reduce their effects on noise, air quality, energy, and water quality. These changes are summarized in this section.

Noise Issues – Noise certification standards for aircraft have been established by the ICAO. These standards have been incorporated into national legislation and are known in the U.S. Federal Aviation Regulations as Stage 2, Stage 3, and Stage 4 standards. Each stage includes new aircraft that are required to meet stricter noise standards. Stage 2 included standards for jet-powered aircraft designed before 1977, including the Boeing 727 and the Douglas DC-9. Unless Stage 2 aircraft have been re-engined to meet later standards, they have been banned by both the U.S. and EU. An alternative is when Stage 2 aircraft have been hushkitted, where a device for reducing noise from an engine is applied; most commonly this term refers to devices which reduce noise emissions from low-bypass turbofan engines, as fitted to older commercial aircraft. Stage 3 aircraft included the Boeing 737-300/400, Boeing 767, and Airbus A319. The deadline for new aircraft to meet the Stage 3 standards was January 1999. More stringent Stage 4 standards were enacted in January 2006 and became applicable to newly certified aircraft and to Stage 3 aircraft for which re-certification to Stage 4 is requested (ICAO, 2010). In 2008, just under 20% of the world fleet did not meet Stage 4 standards. As companies upgrade their aircraft, noise levels will be reduced (Morrell, 2011).

In addition to utilizing quieter aircraft, air cargo operators have implemented procedures for take-off and landings that minimize noise exposure to more densely populated communities. In addition, night curfews or restricted night operations are found at many airports, particularly in Europe. At some airports in Europe, airports have a quota count system in which there is an overall noise quota of all individual aircraft landings (Morrell, 2011).

Because cargo airlines frequently schedule their flights during the overnight hours in order to meet their delivery windows and operate most efficiently, they are disproportionately affected by nighttime noise restrictions. Recently, Frankfurt Airport in Germany has banned night flights as part of a court ruling on a suit brought against the airport by residents and environmental groups opposed to the airport's expansion. This ban is effective until a higher court hears the case next year. Because Frankfurt is Europe's largest air cargo hub, air cargo traffic will be greatly affected, particularly freighters operating to China and Central Asia that rely on nighttime flights. Lufthansa Cargo said that the ban would cost it millions in Euros and would result in flights being rearranged or cancelled. It has warned in the past that it might have to sell its entire fleet of 18 MD-11 freighters if night flights are banned. This presumably temporary restriction on nighttime flights will result in a significant restructuring of air freight logistics in Europe. Also, Dubai and the smaller Gulf airports are likely to take some trans-shipment business from Frankfurt (Handy Shipping Guide, 2011).

In the U.S., the Airport Noise and Capacity Act of 1990 (ANCA), 49 U.S.C. sec. 47521 et seq., as implemented by 14 C.F.R. Part 161, requires that airports that want to impose mandatory curfews to restrict the hours of Stage 3 aircraft seek the approval of the FAA unless the restriction was already in effect on October 1, 1990, in which case the curfew is "grandfathered" and not subject to the requirements of the ANCA. While airports have sought to impose noise curfews at night, they will not receive FAA approval unless six statutory conditions are met (Lang, 2009). These conditions are:

- The restriction is reasonable, non-arbitrary, and nondiscriminatory.
- The restriction does not create an undue burden on interstate or foreign commerce.
- The restriction is not inconsistent with maintaining the safe and efficient use of the navigable airspace.
- The restriction does not conflict with a law or regulation of the U.S.
- An adequate opportunity has been provided for public comment on the restriction.
- The restriction does not create an undue burden on the national aviation system.

Air Quality Issues – Aircraft engines produce emissions that are similar to other emissions resulting from fossil fuel combustion. Unlike other sources, aircraft emissions are unusual in that a significant proportion is emitted at high altitudes. Aircraft emission standards in the U.S. are established by the Environmental Protection Agency (EPA). The FAA is responsible for enforcing these standards. Historically, the EPA has worked with the FAA and the United Nations International Civil Aviation Organization (ICAO) and the FAA in the development of international aircraft standards. Aircraft engines contribute about one percent of the total U.S. mobile source nitrous oxide (NOx) emissions. This level can be as high as four percent in some U.S. airport areas. NOx leads to the formation of ground-level ozone and results in adverse effects to human health, visibility, crop damage, and acid rain. The first EPA standards for NOx were set in 1997 but were not as stringent as ICAO's standards. The EPA recently established standards that are about 16% more stringent than existing NOx standards and will be equivalent to ICAO standards (EPA website, 2011).

Increased international attention is being placed on the contribution of aircraft to Global Greenhouse Emissions and their effects on local air quality at ground level. The air cargo contribution to global CO_2 emissions in 2002 (on both freighter and passenger flights) amounted to between 0.3% and 0.6%, or between 0.6% and 1.1% if a radiative forcing multiplier of 1.9 is included (Morrell, 2011). The ICAO's Committee on Aviation Environmental Protection (CAEP) set a target date of 2013 for completing the CO_2 standard for aircraft emissions. However, developing a global standard has proved to be contentious and the timetable may be delayed. Aircraft manufacturers are concerned that a poorly designed standard could have unintended consequences for aircraft design and environmental groups are worried that the standard may not be rigorous enough to push the industry to be as fuel efficient as possible (Warwick, 2011). Since emissions levels are related to fuel consumption, the operational and technological innovations that the air cargo industry is implementing to reduce fuel use will also reduce greenhouse gas emissions. These innovations are discussed in the following section.

Energy Conservation Issues – With the rise in fuel costs, energy conservation has become very important to the air cargo industry as one way the industry can improve its profitability while reducing its environmental impact. Fuel conservation measures have been implemented by air cargo businesses to reduce energy costs of aircraft, ground vehicles, and air cargo hangars. These measures are described below.

Aircraft – Air cargo businesses are replacing their aircraft with more fuel-efficient planes. They also are utilizing more wide-body planes, which carry more cargo and move cargo farther before refueling, reducing fuel consumption and improving overall fuel efficiency. Carriers are implementing operational procedures to reduce fuel utilized in landings and take-offs, as well as on the ground. For example, FedEx utilizes wide-body planes with flight management systems (FMS) which use continuous approach descent, which keeps the plane in idle during the descent and reduces the engine thrust and fuel consumption. Also, FedEx has reduced in-gate auxiliary power unit usage, which has eliminated over 1.5 hours of engine use per flight throughout the fleet, saving approximately one million gallons of jet fuel per month (FedEx, 2011). UPS utilizes lower flight speeds, computer-optimized flight plans, and computer-managed aircraft gate departures and arrivals, and taxi times to reduce fuel consumption. Air cargo carriers are adapting new technological approaches to air traffic control, such as those associated with the "NextGen" program of the FAA, including utilizing global positioning Systems (GPS) and navigation technology to make air travel more efficient and direct, particularly in high-traffic areas (UPS, 2010).

The use of alternative fuels for aviation also is being explored. The ICAO organized a workshop on Aviation and Alternative Fuels in February 2009 to explore the use of sustainable alternative fuels for aviation. The ICAO then held a Conference on Aviation and Alternative Fuels in November 2009 which endorsed the use of sustainable alternative fuels for aviation, particularly the use of drop-in fuels in the near future, as an important way to reduce aviation emissions. Drop-in fuel is a substitute for conventional jet fuel, which is completely interchangeable and compatible with conventional jet fuel when blended with conventional jet fuel. A drop-in fuel blend does not require adaptation of the aircraft/engine fuel system or the fuel distribution network, and can be used "as is" on currently flying turbine-powered aircraft. The development of sustainable alternative fuels for aviation is facilitated by the ICAO Global Framework for Aviation Alternative Fuels (2009), which is a web-based document that is updated by member States and international organizations when new information is available (ICAO, Air Transport Bureau website, 2011).

Ground Vehicles – Air cargo businesses are utilizing energy-efficient ground support vehicles. For example, ground support equipment at FedEx operations at select airports has been converted from internal combustion engine models to electric units and UPS uses bio-diesel fuel in its ground support equipment.

Air Cargo Hangars and Warehouses – Several air cargo carriers have integrated environmental sustainability features into their air cargo hangars to reduce their environmental footprint and lower their energy costs. One example is FedEx's cargo facility at O'Hare Airport. This building features one of the largest "green" roofs at an airport in the world. The roof is approximately 175,000 ft^2 and is completely vegetated. In addition to lowering the energy costs of the building by 35% a year, the green roof reduces air pollution, reduces storm water runoff, extends the average life of the roof from 15-20 years to 40-50 years, and reduces airport noise (FedEx, 2011). Both UPS and FedEx utilize solar power in several of its facilities and FedEx utilizes geothermal energy in a facility in Geneva, Switzerland. Additionally, companies are upgrading their lighting fixtures in their facilities with more energy-efficient lamps.

Water Quality Issues – UPS has initiated water conservation practices to minimize water use. These practices include dry-washing airplanes using an environmentally friendly enzyme wash agent that reduces the need for rinse water. Companies are also installing low-flow water fixtures in their facilities (UPS, 2011).

SUMMARY

This literature review examined general trends in airport strategic planning and master planning on a macro level and then researched specific micro-level trends in air cargo operations, planning and development. Many papers reviewed were critical of the current methodologies utilized for airport strategic planning and master planning. These papers presented compelling arguments that strategic planning and master planning as it is undertaken today utilizing guidelines by the FAA and ICAO is too rigid and focused on the development of plans rather than the decision-making process. Because of the uncertainties which exist at airports, a more flexible, adaptive approach to airport strategic planning and master planning should be adopted.

In reviewing the literature and research focused on the air cargo industry, specifically, it was apparent that this literature is relatively sparse in comparison to the research that has been done for passenger air transport. The air cargo industry is continually changing with the changes in technology, commodity type and demand. In addition, it will continue to face more economic challenges with the increasing security and environmental regulations. Air cargo companies will have to remain flexible and adaptive to these changes as will airports. In addition, this literature search identified several areas where further research should be conducted to improve the efficiency and financial viability of air cargo companies. These areas include:

- The collection of air cargo data for use in forecasts required to determine future airport facility requirements;
- Operational research to improve the efficiencies of air cargo companies in cargo handling and load planning;
- Revenue management system research to increase the revenues of air cargo companies; and
- Develop a better understanding of the air cargo supply chain to improve the collaboration between freight forwarders and shippers and optimize cargo movement.

CHAPTER 3: SUBTASK 2.2—LITERATURE REVIEW: REVIEW AND ANALYSIS OF AIR CARGO FACILITY-RELATED AIRPORT MASTER PLANS

CHAPTER OVERVIEW

A review and analysis of 12 airport master plans completed between 2005 and 2011 was conducted to identify recent innovative trends in air cargo facility master planning. The literature review focused on four components of the air cargo master planning process: air cargo volume forecasts, air cargo aircraft operations forecasts, facility requirements, and recommendations. For air cargo volume forecasts, the master plans primarily used traditional methodologies that involved statistical models and consideration of factors such as the airport's historic air cargo volumes and global, national, and local air cargo and socioeconomic trends and forecasts. Four master plans, however, were more innovative and used market share approaches or probabilistic forecasting. A minimal number of airport master plans used unique approaches to forecasting air cargo aircraft operations. Standard techniques involved consideration of factors such as historical air cargo tonnage per aircraft operation, existing and future aircraft sizes, and global and national forecasts prepared by Boeing, Airbus, and the FAA. One airport, however, used a methodology that involved the development of average annual day cargo schedules and another used probabilistic forecasting. Notably missing from the airport master plans were innovative methods used to estimate future air cargo facility requirements. Facility requirements were calculated through the application of planning factors based on widely-used industry standards or local conditions. Lastly, the airport master plans typically provided recommendations related to future air cargo development for a twenty year period. One airport master plan looked ahead 50 years and provided guidance for reserving land for future airport expansion.

INTRODUCTION

The review of existing data regarding airport master planning is important to set the stage in terms of a historical perspective and serve as a foundation for the study. As part of this task the research team compiled and reviewed past airport planning and master planning documents from a wide variety of airport types. Nineteen airport master plans were collected and, based on their scale of operations and depth of master plan detail, 12 were reviewed and analyzed with a focus on air cargo planning content. Table 3-1 identifies airport master plans collected and reviewed. Each airport in Table 3-2 has a summary profile on the following pages which identifies source data utilized in each master plan as it relates to air cargo. Figure 3-1 displays the location of each airport with a summary profile. In addition, the collection of airport master plans identifies additional air cargo relevant attributes such as:

- Airport characteristics (number of annual operations, number of runways)
- Community characteristics (population, major industries)
- Airport primary purpose (passenger, cargo, general aviation, military, local demand, refueling)
- Geographic location
- Airport ownership and management structure

Table 3-1 Airport Master Planning Documents Collected.

Airport Name	Reviewed and Analyzed	YEAR	ACI Cargo Rank 2010
Boise Air Terminal/Gowen Field	Yes	2010	74
Capital City Airport	Yes	2006	94
Casper/Natrona County International Airport	No	2008	115
Cincinnati/Northern Kentucky International	Yes	2005	17
Colorado Springs Airport	No	2010	109
Dallas/Fort Worth International Airport	Yes	2009	11
Dona Ana County Airport at Santa Teresa, NM	Yes	2008	NA
George Bush Intercontinental Airport	Yes	2006	15
Kansas City International Airport	Yes	2009	45
Memphis International Airport	Yes	2010	1
Norman Y. Mineta San Jose International Airport	No	2011	66
Oakland International Airport	Yes	2006	12
Palm Beach International Airport	No	2006	95
Piedmont Triad International Airport	Yes	2010	46
Portland International Airport	Yes	2010	28
Portland International Jetport (Maine)	No	2007	NA
San Antonio International Airport	Yes	2010	33
Sioux Falls Regional Airport – Joe Foss Field	No	2006	84
Washington-Baltimore Regional Air Cargo Study	No	2008	40

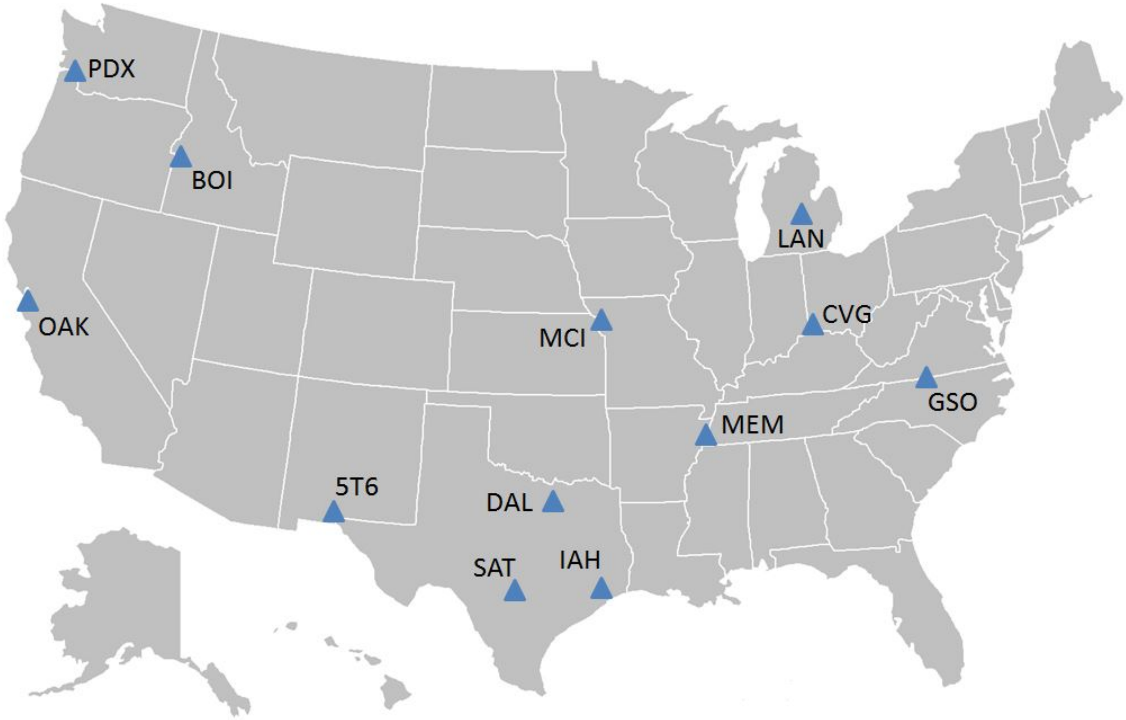
SOURCE: CDM Smith.

Table 3-2 Airport Master Planning Documents Reviewed and Analyzed.

	City	ACI Cargo Volume Rank	Cargo Activity	Prime Consultant	Year	Cargo Volume Forecast Method
Boise Airport, BOI	Boise, ID	74	Non hub	Ricondo & Associates	2010	National and historic trends
Capital Region International Airport, LAN	Lansing, MI	94	Non hub	RS&H	2006	Historical trends
Cincinnati/ Northern Kentucky International Airport, CVG	Cincinnati, OH	17	Non hub (at time of analysis)	Landrum & Brown	2005	None
Dallas/Fort Worth International Airport, DFW	Dallas/Fort Worth TX	11	Hub	URS	2009	Blended growth rates
Dona Ana County Airport, 5T6	Santa Teresa, NM	NA	Non hub	WHPacific	2008	Blended growth rates and market share based on El Paso cargo activity
George Bush Interconti-nental Airport, IAH	Houston, TX	15	Gateway	DMJM Aviation	2006	Local and national economic trends
Kansas City International Airport, MCI	Kansas City, MO	45	Non hub	Landrum & Brown	2009	Historical trends
Memphis International Airport, MEM	Memphis, TN	1	Hub	Jacobs Consultancy	2010	FedEx trends and historic trends
Oakland International Airport, OAK	Oakland, CA	12	Hub		2006	Average Annual Day
Piedmont Triad International Airport, GSO	Greensboro, NC	46	Hub	Jacobs Consultancy	2010	Boeing and Airbus, Historic belly and mail
Portland International Airport, PDX	Portland, OR	28	Gateway	Jacobs Consultancy	2010	Econometric model & probabilistic forecasts
San Antonio International Airport, SAT	San Antonio TX	33	Non hub	AECOM	2010	Blended growth rates

SOURCE: CDM Smith.

Figure 3-1 Locations of Airports with Summary Profiles. (SOURCE: CDM Smith, Google Earth Pro).



An airport master plan is a document used to guide decisions for the airport's future layout and environs. A typical airport master plan includes inventory, forecasts, facility requirements, alternatives, financial plan/implementation, and an airport layout plan or schematic of what the airport layout will be in the future. All facilities within the environs of the airport, such as terminal space, automobile parking, and cargo facilities are included in the plan. For large airports, the airport planning process is often continuous where plans for specific functions of the airport are conducted incrementally. For example, the airport may conduct an airport wastewater treatment master plan or develop plans for deicing facilities. Other ongoing planning studies may be related to passenger and cargo security issues. These separate studies offer a continuous flow of information to airport decision makers and in order to keep the airport compliant in the regulated world of aviation.

BOISE AIRPORT – BOISE, ID
AIRPORT OVERVIEW

Boise Airport is the primary commercial service airport serving the City of Boise, southwestern Idaho, eastern Oregon, and northern Nevada. Owned by the City of Boise and operated by the City of Boise Department of Aviation and Public Transportation, the airport is located approximately three miles south of downtown Boise. Primary access to the airport is provided via Interstate 84. The airport occupies an approximate 5,000-acre site.

Boise Airport experiences approximately 122,000 annual aircraft operations. The airport has two parallel runways, both of which are equipped with instrument landing systems. Runway 10R/28L is the primary runway, measuring 9,763 feet long by 150 feet wide. This runway was upgraded to a Category III Instrument Landing System with minimums to 600 feet in 2007, which gives the airport one of the safest and most efficient landing systems in the United States. The airport is also supported by a recently expanded passenger terminal building and a new air traffic control tower which opened in 2013.

Boise Airport is classified as a small hub airport in the National Plan of Integrated Airport Systems (NPIAS), offering non-stop passenger service to 18 cities in the United States. According to the 2010 Airports Council International – North American Final Rankings (ACI-NAFR), the airport is currently served by eight airlines which handled over 2.8 million passengers in 201; in addition, more than 36,000 metric tons of air cargo was handled at the airport in 2010 by the passenger airlines as well as FedEx Express, UPS, and Western Air Express.

AIRPORT MASTER PLAN

The previous master plan update for Boise Airport was finalized in 2001. Over the next five years, several capital improvement projects were completed at the airport, and there were significant changes in the aviation industry. It was therefore determined in 2006 that a Master Plan Update was necessary. Ricondo & Associates, Inc. was selected to complete the Master Plan Update, which was finalized in 2009.

Air Cargo Methodology

Existing Conditions

In 2007, the cargo and passenger carriers at Boise Airport included FedEx Express, UPS, United Airlines, Delta Airlines, Horizon Air, and Southwest Airlines. Combined, these carriers handled 46,676 U.S. tons of freight and 253 U.S. tons of mail at the airport in 2007. FedEx Express and UPS both leased land at the airport, with FedEx Express' operations occurring in the airport's cargo area east of the passenger terminal apron and UPS' operations occurring south of the Runway 10R threshold. FedEx Express' facility was used for package sorting, equipment storage, and office space. UPS' facility included one building and ramp space. The passenger airlines, which handled mail as belly cargo, had cargo facilities located in the cargo area east of the terminal apron. Total building space dedicated to air cargo at the airport was approximately 73,700 ft^2.

Air Cargo Volume Forecasts

Air cargo volume forecasts for the Master Plan Update were prepared in 2006 using 2005 as the base year. The forecasts were based on the following assumptions:

- National aviation industry trends
- Policy goals and objectives of Boise Airport
- Historical activity levels and trends in air service at the airport
- Local socioeconomic and demographic trends, compared with State and national trends

Separate forecasts were prepared for air freight and air mail, which are discussed below.

- *Air Freight* – Air freight was projected to grow at a growth rate greater than four percent between 2005 and 2015 and between three and four percent between 2015 and 2030. The lower growth after 2015 was projected because the Boise cargo market would mature and other airports in the region would become more competitive. It was noted that although total air freight handled at Boise Airport was down in 2005, future growth would occur along with the rest of the U.S. It was also noted that Boise Airport would potentially experience growth in air freight due to congested airports and air cargo facilities at other airports in the region and lower operating costs in Boise.

Total air freight was forecast to grow from approximately 91.5 million pounds in 2005 to approximately 233.6 million pounds in 2030 at an annual growth rate of 3.8%.

- *Air Mail* – Beginning in 2001, a major change occurred in the transport of air mail at Boise Airport. Historically, the United States Postal Service (USPS) carried express mail in the U.S. However, in August 2001, the USPS entered into a long-term contract with FedEx Express to carry the majority of express mail. Also, following the events of September 11, the passenger airlines were prohibited from carrying mail over 16 ounces. This resulted in an even greater volume of domestic mail handled by FedEx Express. Because of these events and the uncertainty associated with potential security changes, Ricondo & Associates noted the difficulty in forecasting short-term volumes of air mail at Boise Airport. Long-term volumes were assumed to eventually experience normal growth. Total air mail volume handled at Boise Airport was forecast to grow from approximately 2.1 million pounds in 2005 to approximately 4.9 million pounds in 2030 at an annual growth rate of 3.4%.

Aircraft Operations Forecasts

Aircraft operations forecasts for FedEx Express and UPS were prepared using the same assumptions used for the air cargo volume forecasts. Historical operations data for FedEx Express and UPS showed annual operations decreased at the airport from 10,412 (42% of all air carrier flights) in 2000 to 7,208 (33% of all air carrier flights) in 2005. The overall number of future operations was projected to increase, but the share of these flights was projected to decrease, primarily due to FedEx Express and UPS increasing the size of their aircraft. Total aircraft operations by the integrated cargo carriers were forecast to grow from 7,208 in 2005 to 11,427 in 2030 at an annual growth rate of 1.9%.

Facility Requirements

To estimate future air cargo facility requirements, Ricondo & Associates utilized planning factors represented by the number of annual tons of air cargo processed per square foot of cargo building. The airport's existing utilization ratio, based on 2007 air cargo volumes, was 0.64 annual U.S. tons per square foot. Ricondo & Associates noted that this was below the industry standard of 1.5 annual U.S. tons per square foot.

Two sets of future facility requirements were estimated by applying the existing utilization ratio and the industry standard ratio to the air cargo volume forecasts. Based on the existing utilization ratio, it was estimated that a total of 187,300 ft^2 of building space would be required in 2030, with 113,610 ft^2 of additional building space necessary. Based on the industry standard ratio, it was estimated that a total of 79,500 ft^2 of building space would be required in 2030, with 5,810 ft^2 of additional building space necessary. The analysis concluded that Boise Airport's existing cargo facilities could accommodate some future demand in the short term, but utilization at the industry standard level of 1.5 U.S. tons per square foot may not be possible due to the carriers' preferences and secondary uses within the buildings. A more detailed analysis of building space requirements would be necessary before future air cargo facilities were developed.

With regard to cargo building dimensions, the Master Plan Update noted the typical depth of 100 to 150 feet for cargo buildings. Ricondo & Associates assumed future cargo buildings at Boise Airport would have a depth of 125 feet. Based on this Table and the existing utilization ratio, a building approximately 900 feet long would be required. Using the industry standard ratio, 46 linear feet of additional building space would be required.

Master Plan Recommendations

A concepts analysis identified air cargo development alternatives that could satisfy future demand, were responsive to the needs of the communities served by the airport, maximized revenue-generating opportunities, and effectively managed land uses. The existing air cargo facilities at Boise Airport were located in three separate areas, including east and west of the passenger terminal as well as south of Runway 10R/28L at the western boundary of the airport. It was noted that the existing configuration would result in redundant facility operations, increased costs for screening air cargo, and continued runway crossings for air cargo aircraft. Ricondo & Associates recommended consolidating the airport's cargo facilities in one location south of Runway 10R/28L, which would promote the use of Runway 10R/28L for cargo operations and eliminate the need for cargo operations to cross runway 10L/28R.

Two alternatives that met the goal of consolidating air cargo facilities south of Runway 10R/28L included a consolidated west cargo complex and a consolidated midfield cargo complex. The Master Plan Update selected the consolidated midfield cargo complex as the preferred air cargo development because it provided a consolidated location for security screening of air cargo shipments, resulted in more efficient use of air cargo facilities, and maximized expansion capabilities.

CAPITAL REGION INTERNATIONAL AIRPORT – LANSING, MI

AIRPORT OVERVIEW

Capital Region International Airport is the primary commercial service airport serving the City of Lansing, the state of capital of Michigan, and the Tri-County area comprised of Clinton County, Ingham County, and Eaton County. Owned and operated by the Capital Region Airport Authority (CRAA), the airport is located approximately four miles northwest of downtown Lansing. Primary access to the airport is provided via North Grand River Avenue, from I-69/I-96 to the west or downtown Lansing to the southeast. The airport occupies an approximate 2,000-acre site.

Capital Region International Airport experiences approximately 42,000 annual aircraft operations (AIC-NA, 2010). The airport has two parallel runways and a third crosswind runway. Runway 10R/28L is the primary runway, measuring 8,506 feet long by 150 feet wide, and is equipped at both ends with instrument landing systems. The airport is also supported by a 165,000 ft^2 passenger terminal building.

Capital Region International Airport is classified as a non-hub airport in NPIAS, offering daily non-stop service to Detroit, Michigan; Minneapolis, Minnesota; and Chicago, Illinois. The airport is currently served by three airlines which accommodated over 257,000 passengers in 2010 (AIC-NA, 2010). In addition, nearly 19,000 metric tons of air cargo was handled at the airport in 2010 (AIC-NA, 2010).

AIRPORT MASTER PLAN

The previous Master Plan Update for Capital Region International Airport was completed in 1995. As part of the continuous planning process, a Master Plan Update was completed in 2006. The consulting firm of Reynolds, Smith and Hills, Inc. (RS&H) was selected to complete the study, which considered 2003 through 2023 as the planning period.

Air Cargo Methodology

Existing Conditions

In 2003, Capital Region International Airport was served by seven passenger airlines, including Comair, Midwest Connection, United Express, US Airways Express, Continental Connection, Allegiant Air, and Northwest Airlink. The airport was also served by two cargo carriers, United Parcel Service (UPS) and Superior Aviation, a contractor to UPS that served as a feeder airline to smaller market areas. Total air cargo handled by the passenger and cargo carriers in 2003, the majority of which was UPS, including express packages, mail, and other freight, was approximately 49.5 million pounds. This was a significant decrease from the airport's peak of approximately 65.2 million pounds in 2000. Air cargo volumes were decreasing at the airport due to the effects of the economic recession and the events of September 11, 2001.

The airport's air cargo facilities were constructed in 1991 and were located on the east side of the airfield. Approximately 12,500 ft^2 of building space was occupied by UPS, which included a sorting facility. Total ramp space dedicated to air cargo was approximately 15,000 yd^2.

Air Cargo Volume Forecasts

RS&H noted that air cargo growth at Capital Region International Airport was historically tied to the economic and demographic characteristics of the Lansing region and the state of Michigan. Several regression analyses were conducted using historical population, employment, and per capita personal income data to determine which of these independent variables had the strongest correlation to historical air cargo tonnage at the airport. It was determined from these analyses that the population of the state was most strongly correlated to air cargo growth at the airport.

Based on this methodology, total air cargo tonnage at Capital Region International Airport was forecast to increase from 65.2 million pounds in 2000 to 143.9 million pounds in 2023, representing an average annual growth rate of 3.5%.

Air Cargo Aircraft Operations Forecasts

RS&H provided limited information in the Master Plan Update regarding the methodology used to forecast cargo operations as well as the number of future cargo operations. The methodology was based on historical trends and forecast air cargo tonnage. Total air carrier cargo operations were forecast to increase from 1,358 in 2003 to 2,100 in 2023, representing an average annual growth rate of 2.2%.

Facility Requirements

Facility requirements that would accommodate projected air cargo tonnage through 2023 were developed for three facility components:

- *Air Cargo Processing Facility* – UPS' existing sort facility lacked the capacity to meet the demand during peak periods such as Christmas. Delays were experienced during these periods. UPS indicated that it was willing to accept the peak period delays as long as its facilities were able to maintain a 25% "surge potential" beyond the off-peak demand. RS&H used this criterion to develop estimates of future cargo processing facility requirements. In 2003, Capital Region International Airport processed approximately 4,000 pounds (2 U.S. tons) of air cargo per square foot of cargo building space. In 2000, when the airport processed the largest volume of air cargo in its history, the airport processed approximately 5,000 pounds (2.5 U.S. tons) per square foot. Based on this historical data and UPS' desire to maintain a 25% surge potential, RS&H used the conservative planning factor of 4,000 pounds (two U.S. tons) per square foot to estimate future air cargo processing facility requirements. For 2023, it was estimated that a total of 36,500 ft^2 of cargo processing space would be required to meet forecast demand. As mentioned previously, UPS' existing facility totaled 12,500 ft^2.

- *Aircraft Apron* – To estimate future apron requirements, RS&H considered several factors including the airport's existing apron space dedicated to air cargo, the aircraft types used by UPS and Superior Aviation (Boeing 757s and Cessna Caravans/Fairchild Merlins, respectively), and the forecasts of air cargo tonnage and aircraft operations. Calculations determined that the airport's existing cargo apron had an approximate capacity for three Boeing 757s or a combination of two Boeing 757s, based on the general space requirements of 5,400 yd^2 for a Boeing 757 and 2,100 yd^2 for a Cessna Caravan or Fairchild Merlin. A typical day of UPS flights to UPS' hub in Louisville, Kentucky was then compared with the ratio between total cargo tonnage and total cargo operations over the planning period, which showed that the existing apron did not require expansion to accommodate forecast cargo tonnage. However, it was noted that the analysis did not consider Superior Aviation's activity or the possibility that an additional cargo operator would initiate service at the airport in the future. It was therefore recommended that approximately 15,000 yd^2 of ramp space should be reserved for a potential additional cargo operator.
- *Landside Area* – The landside areas (employee parking, truck docks, etc.) experienced delays during peak periods similar to the sort facility. It was assumed that the landside areas would need to be expanded throughout the planning period as the sort facility was expanded. Therefore, the percentage increase in sort facility requirements was applied to the landside areas to estimate future landside requirements. Using this methodology, the existing 4,500 ft^2 of landside area would need to expand to 13,000 ft^2 by 2023.

Master Plan Recommendations

RS&H recommended that a 45-acre site containing undeveloped land directly east of the airport's existing cargo facilities should be reserved for future air cargo facility development. This site exceeded the 13 acres that would be required in the future. The recommended site had been previously identified by the CRAA for future cargo development.

CINCINNATI/NORTHERN KENTUCKY INTERNATIONAL AIRPORT – COVINGTON, KY

AIRPORT OVERVIEW

Cincinnati/Northern Kentucky International Airport is the primary commercial service airport serving the Tri-State region comprised of Southwest Ohio, Southeast Indiana, and Northern Kentucky. Owned and operated by the Kenton County Airport Board, the airport is located 13 miles southwest of downtown Cincinnati in Northern Kentucky. Primary access to the airport is provided via I-275 and State Route 212. The airport occupies an approximate 8,000-acre site.

Cincinnati/Northern Kentucky International Airport experiences approximately 178,000 annual aircraft operations (AIC-NA, 2010). The airport has three parallel runways and one crosswind runway, all of which are equipped with instrument landing systems. Runway 18L/36R is the primary runway, measuring 10,000 feet long by 150 feet wide. The airport's newest runway, Runway 18R/36L, opened in December 2005 and measures 8,000 feet long by 150 feet wide. The airport is supported by three passenger terminal buildings, two of which currently serve airline passengers.

Cincinnati/Northern Kentucky International Airport is classified as a medium hub airport in the NPIAS, offering non-stop service to 52 domestic and three international destinations, including Paris. The airport, currently served by seven passenger airlines, handled nearly 8.0 million passengers in 2010 (AIC-NA, 2010). In addition, more than 371,000 metric tons of air cargo was transported in 2010 at the airport, which is home to DHL Express' main U.S. hub – one of three global "Super Hubs" from which DHL Express serves 220 countries (AIC-NA, 2010).

AIRPORT MASTER PLAN

During the course of this ACRP 03-24 project, the Kenton County Airport Board was in the process of completing a 2012 Master Plan Update for Cincinnati/Northern Kentucky International Airport. The study began in 2011 and was scheduled for completion in 2012 but was not published and released to the public until 2013. The Airport Board thought the update of the previous 2005 Master Plan Update was necessary because of several unpredicted changes in the U.S. aviation industry, including a severe economic recession, record high fuel prices, the reorganization of multiple network carriers under Chapter 11 bankruptcy protection, legacy airline consolidation, increased security measures and processes, advancements in technology of airline check-in procedures, and the evolution of airline fleets. The Cincinnati/Northern Kentucky International Airport 2012 Master Plan Update considered the possible effects of a potential operational transition through 2035 from an airport historically dominated by Delta Air Lines' hub to a competitive multi-carrier environment. The update provided the Kenton County Airport Board an opportunity to identify and evaluate strategic business opportunities in an ever changing economic environment. Lastly, the update ensured the continued operation of a safe, efficient, and environmentally compatible airport.

The 2005 Master Plan Update, initiated in 2003 and finalized in 2007, laid the foundation for future development at the airport through 2025. It is this 2005 study that was analyzed for this ACRP report since it was made available by Kenton County Airport Board to the research team. Going back further in time, the previous Master Plan Update for the airport was completed in 1996. The 1996 Master Plan Update identified facilities expected to be required through 2011. In 2003, the Kenton County Airport Board decided that a Master Plan Update was necessary because of several national and local changes in the aviation industry, including major growth and development in the Tri-State region, heightened security requirements, industry consolidation of airport hubs, and the relocation of DHL's cargo sort hub to Wilmington, OH. Landrum & Brown, Inc. was selected to complete the 2005 Master Plan Update. Below is a summary of the 2005 Master Plan Update.

Air Cargo Methodology

Existing Conditions

The all-cargo carriers serving Cincinnati/Northern Kentucky International Airport during the master planning process included DHL, FedEx Express, Target Logistics, and Northwest. Federal Reserve check haulers also operated at the airport. DHL operated a hub at the airport since 1984 and completed construction of a new 150-acre sort facility and aircraft apron in 2003. The passenger airlines providing belly cargo services included Delta Air Lines and its affiliates, United Airlines, American Airlines, and US Airways. The airport's freight forwarders included PANNCO, OKI, and Emery Worldwide. Lastly, the USPS operated a facility on the airport.

Annual cargo tonnage handled at the airport grew significantly between 1989 and 2003, increasing from 93,560 U.S. tons in 1989 to 425,600 U.S. tons in 2003. Likewise, annual air cargo aircraft operations experienced considerable growth, increasing from 19,950 in 1992 to approximately 40,000 in 2003. The growth in cargo tonnage and operations was primarily due to DHL's hub operation. DHL announced in June 2004, however, that it was relocating its hub to Wilmington, OH in September 2005. DHL later relocated its U.S. hub from Wilmington, OH back to Cincinnati/Northern Kentucky International Airport in 2009.

The following briefly describes the cargo facilities existing at Cincinnati/Northern Kentucky International Airport during the master planning process:

- *DHL* – DHL's cargo sort hub facility was located in the South Airfield between the Runway 36C and 36R ends. There was also a DHL sort hub facility no longer in use that was located in the airport's west service area near the rental car facility. Because DHL was relocating their hub to Wilmington, OH, the new sort facility was underutilized.
- *FedEx Express* – FedEx Express used a 5,000 ft^2 portion of a joint-use air cargo building located near Terminal 1 in the passenger terminal area for processing cargo.
- *Delta Air Cargo* – Delta Air Lines cargo operations were located northeast of the passenger terminal area in a 103,000 ft^2 facility. Total truck and auto parking space available was 92,350 ft^2.
- *USPS* – The USPS occupied a building totaling 57,332 ft^2 of space located northwest of the passenger terminal area.
- Freight Forwarders
    - *PANNCO* – PANNCO's air freight facility consisted of a 9,000 ft^2 building located in the airport's west service area. The facility handled freight forwarding for United Airlines and American Airlines via Worldwide Flight Services.
    - *Emery Worldwide* – Emery Worldwide's 15,000 ft^2 building was located north of the passenger terminal area within the airport's west service area. Emery handled all truck-to-truck cargo and did not use aircraft at the airport.
    - *OKI* – The OKI air freight facility consisted of a 45,600 ft^2 building located in the airport's west service area. The building housed multiple tenants and was not used directly for air cargo operations.

Air Cargo Volume Forecasts

Forecasts of air cargo volumes at Cincinnati/Northern Kentucky International Airport were developed in a study separate from the 2005 Master Plan Update. In 2003, the Kenton County Airport Board completed a Terminal Area Master Plan (TAMP). The primary objective of the TAMP involved planning for an expanded terminal building designed to consolidate all airlines into a single facility. The 2005 Master Plan Update used the air cargo volume forecasts from the TAMP. The methodology used to derive the forecasts in the TAMP was not discussed in the 2005 Master Plan Update. In the TAMP, air cargo tonnage was forecast to increase from 425,600 U.S. tons in 2003 to nearly 2.2 million U.S. tons in 2025 at an average annual growth rate of 7.7%.

Aircraft Operations Forecasts

All-cargo aircraft operations were forecast in the 2005 Master Plan Update for the period 2003 through 2025. However, only limited information regarding the methodology used to derive the forecasts was available. Two important factors affecting the cargo operations forecasts were DHL's relocation of its hub to Wilmington, OH in 2005 and the Check Clearing for the 21st Century Act (Check 21), which became effective in October 2004. Check 21 allowed banks to use electronic images of checks, which eliminated the need to transport checks. Check hauler cargo flights were projected to be phased out by 2010. After considering the effects of these factors on cargo operations at Cincinnati/Northern Kentucky International Airport, Landrum & Brown projected all-cargo operations to total 27,380 in 2010, with the assumption that other cargo carriers would increase operations following DHL's departure. From 2010 to

2025, moderate annual growth of one percent was expected. Cargo operations were projected to total 31,610 in 2025.

Facility Requirements and Master Plan Recommendations

Detailed future cargo facility requirements or recommendations were not available in the 2005 Master Plan Update because of DHL capacity and the uncertainty of future cargo operations at Cincinnati/Northern Kentucky International Airport. The 2005 Master Plan Update provided the following future cargo facility requirements and recommendations at the airport:

- *DHL* – With DHL's relocation of its hub to Wilmington, OH, Landrum & Brown assumed DHL's South Airfield cargo facility would be re-used in some capacity in the future. No future growth projections were made for DHL.
- *FedEx Express* – During the 2003 TAMP study, FedEx Express personnel stated they would need a 50,000 ft^2 hangar to accommodate their needs through the planning period. Based on this information, FedEx Express' future facility requirements in the 2005 Master Plan Update totaled 55,000 ft^2 of cargo building space, plus aircraft ramp, auto parking, and circulation.
- *Delta Air Cargo* – The 2005 Master Plan Update based Delta Air Lines' belly cargo requirements on air cargo tonnage data and space requirements provided by Delta personnel during the 2003 TAMP study. Based on industry standards that blend belly, freight, and express cargo, a planning factor of 1.0 ton of air cargo per square foot of building space used in the TAMP study, Delta's cargo building space requirements were projected to increase from 83,000 ft^2 in 2000 to 117,100 ft^2 in 2020. A planning factor of 1.1 ft^2 of parking space per ton of air cargo was used in the TAMP study to project truck/automobile parking space requirements for Delta. According to the TAMP study, Delta's existing 92,350 ft^2 of parking space in 2000 would need to increase to 130,300 ft^2 in 2020. When the building space and parking area requirements are combined, Delta had a surplus of 20,000 ft^2 of total cargo facility space at the airport in 2000. By 2020, Delta was projected to have a deficit of 52,050 ft^2 of total cargo facility space.
- *USPS* – USPS personnel indicated during the TAMP study that the existing 57,332 ft^2 facility would be adequate throughout the planning period.
- Freight Forwarders
  - *PANNCO* – PANNCO's air freight facility was located in an area that was identified for the future Concourse D airline gate expansion. The facility would require relocation to accommodate the Concourse D expansion.
  - *Emery Worldwide* – Emery handled all truck-to-truck cargo and did not use aircraft at the airport. Therefore, there were no air cargo requirements for this facility. Like the PANNCO air freight facility, the Emery facility would need to be relocated to accommodate the Concourse D expansion.
  - *OKI* – Because the OKI building was not used directly for air cargo operations, future requirements were not determined based on air cargo. Landrum & Brown noted the facility would be replaced as warehouse space as needed to accommodate the Concourse D expansion.

DALLAS/FORT WORTH INTERNATIONAL AIRPORT – DALLAS-FORT WORTH, TX

AIRPORT OVERVIEW

Dallas/Fort Worth International Airport is the primary commercial service airport serving the North Central region of Texas and the Dallas-Fort Worth metropolitan area, known as the Dallas/Fort Worth Metroplex. Owned by the cities of Dallas and Fort Worth and operated by the Dallas/Fort Worth

(DFW) Airport Board, the airport is located 18 miles from downtown Dallas and 24 miles from downtown Fort Worth. The airport is accessible via Highways 183, 360, 114, 121, and 635. The airport occupies over 18,000 acres of land.

Dallas/Fort Worth International Airport experiences over 652,000 annual aircraft operations, making it the third busiest airport in the world in 2010. There are seven runways, all of which are equipped with instrument landing systems. The four primary runways include: Runway 17C/35C, which is 13,401 feet long by 150 feet wide; Runway 17R/35L, which is 13,401 feet long by 200 feet wide; Runway 18L/36R, which is 13,400 feet long by 200 feet wide; and Runway 18R/36L, which is 13,400 feet long by 150 feet wide. The airport is also supported by five passenger terminal buildings and two million square feet of cargo warehouse space. The airport is unique in that it has two active control towers and can accommodate four simultaneous aircraft arrivals under visual flight rules.

Dallas/Fort Worth International Airport is a major commercial airline hub offering non-stop service to 145 domestic and 48 international destinations worldwide. The airport is currently served by 19 airlines, 11 domestic and eight international, which handled nearly 57 million passengers in 2010 (AIC-NA, 2010). The airport is the largest hub for American Airlines, serving as a central gateway to the airline's extensive international and domestic network. In addition, more than 645,000 metric tons of air cargo was handled at the airport in 2010 by the passenger airlines, eight all-cargo airlines, and five integrators, including FedEx Express and UPS (AIC-NA, 2010). UPS operates a regional sort hub at the airport.

AIRPORT MASTER PLAN

The DFW Airport Board completed an Airport Development Plan (ADP) in 1997, the purpose of which was to guide development at Dallas / Fort Worth International Airport over the ensuing 10 years. The ADP focused on terminal capacity needs, airfield operational enhancements, and terminal-to-terminal passenger connectivity. With the implementation stage of the ADP completed and a new long-range vision for the airport needed, the DFW Airport Board contracted with URS Corporation (URS) to initiate a master planning process entitled "VFR 2030: Vision of the Future. Realized." in 2007. The purpose of VFR 2030 was to develop a long-range plan for the airport that addressed the airport's aging infrastructure, changes in the aviation industry, and changes in the DFW Airport Board's corporate philosophy since the 1997 ADP. It would also serve as a guide to the DFW Airport Board's individual departments to assist them in achieving the goals outlined in the Board's Strategic Plan, which was updated in 2008.

Air Cargo Methodology

Existing Conditions

VFR 2030 provided an inventory of existing land uses and facilities on Dallas/Fort Worth International Airport. The inventory indicated the existing leasehold areas related to the airport's air cargo carriers totaled 252.7 acres. The inventory also indicated the existing leasehold areas related to warehouse space totaled 305.0 acres.

Air Cargo Volume Forecasts

Four separate air cargo volume forecasts were prepared during the VFR 2030 master planning process. These included baseline forecasts for the all-cargo carriers, integrators, and belly cargo, as well as an alternate high-growth scenario that assumed significant expansion of the UPS cargo hub at the airport. The methodology used for each forecast is described below:

- *All-Cargo* – Separate forecasts were prepared for international all-cargo and domestic all-cargo. Historical data showed that approximately 94% of the air cargo handled by the all-cargo carriers at Dallas/Fort Worth International Airport is from international destinations and the remaining six percent is from domestic destinations. To forecast international all-cargo, URS examined the percentage of international all-cargo activity at the airport as a percentage of imports and exports in the airport's catchment area, defined as a 12-hour drive time from the airport. Data showed this percentage increased from 2003 to 2006, so it was assumed that the airport's international cargo market share of the catchment area would increase in the future. An increase of five percent was assumed by 2015 and an additional two percent by 2025 for a total market share increase of seven percent in the catchment area by 2030. These percentages were applied separately to future imports and exports in the catchment area. Boeing's 2006 *World Air Cargo Forecast 2006-2007* and Airbus' 2006 *Global Market Forecast 2006-2025*, both of which contain growth rates for air cargo volumes transported between the world's major geographic regions, were utilized to derive blended growth rates for exports and imports within those regions. Import/export data from 2006 specific to the Dallas/Fort Worth International Airport catchment area was grouped into the geographic regions in the Boeing and Airbus forecasts, which facilitated application of the blended growth rates. The market share assumptions for the airport's catchment area were in turn applied to the blended growth rates to arrive at estimates of future air cargo tonnage at the airport by geographic region through 2030. Total international all-cargo at Dallas/Fort Worth International Airport was forecast to grow from approximately 290,000 U.S. tons in 2010 to approximately 1.0 million U.S. tons in 2030 at a growth rate of 6.5%.

  To forecast domestic all-cargo, URS calculated an average growth rate for U.S. domestic cargo from the growth rates used in the Boeing and Airbus forecasts (3.8% and 3.3%, respectively). Domestic all-cargo tonnage at Dallas/Fort Worth International Airport was forecast to increase from approximately 18,000 U.S. tons in 2010 to approximately 35,000 U.S. tons in 2030 at a growth rate of 3.5%.
- *Integrators* – A growth rate of 3.5%, which is the average of the growth rates forecast for U.S. domestic cargo by Boeing and Airbus, was used to forecast cargo tonnage by carriers such as UPS and FedEx Express. Integrator cargo tonnage was forecast to increase from approximately 426,000 U.S. tons in 2010 to approximately 848,000 U.S. tons in 2030.
- *Belly Cargo* – URS noted the inconsistent growth in belly cargo activity at the airport between 2003 and 2006 due to market changes driven primarily by the events of September 11, 2001. As a result of the significant decline in belly cargo activity immediately after 2001 and the relatively flat activity since, a conservative growth rate of 0.5% was used for domestic belly cargo. Domestic belly cargo was forecast to increase from approximately 137,000 U.S. tons in 2010 to approximately 151,000 U.S. tons in 2030. A higher growth rate of 3.0% was used for international belly cargo based on the airlines' focus on the more profitable international passenger traffic market. International belly cargo was forecast to increase from approximately 82,000 U.S. tons in 2010 to approximately 149,000 U.S. tons in 2030.
- *Alternate High-Growth Scenario* – As noted above, an alternate forecast was prepared that assumed significant expansion of UPS' regional hub at the airport. UPS' Dallas hub is considered a regional hub along with Philadelphia International Airport and Ontario International Airport, with Ontario International Airport the largest of the regional hubs. This scenario modeled the potential for the Dallas hub to surpass Ontario International as UPS' largest regional hub. Factors considered included airport and airspace capacity, availability of land for expansion, and a strong local economy. The forecast assumed UPS would expand its cargo facility between 2007 and 2009, followed by 26% growth per year in that carrier's air cargo tonnage between 2010 and 2012. The 3.5% growth rate from the baseline forecast for the integrators was used for the 2012

to 2030 period. Total air cargo tonnage handled by UPS under this forecast scenario was projected to increase from approximately 484,000 U.S. tons in 2010 to approximately 1.3 million U.S. tons in 2030 at an annual growth rate of 5.3%.

Aircraft Operations Forecasts

Two air cargo aircraft operations forecasts were prepared during the VFR 2030 master planning process. The baseline forecast projected aircraft operations for the all-cargo carriers and integrators. The methodology involved examining historical ratios of air cargo tonnage per operation and assuming further growth in the average size of aircraft and tonnage per operation. A growth rate of 3.9% was used, with operations increasing from approximately 28,000 in 2010 to approximately 62,000 in 2030.

Similar to the air cargo volume forecasts, an alternate high-growth scenario for UPS was forecast that assumed significant expansion of the integrator's hub at the airport. In this scenario, UPS' aircraft operations were assumed to increase according to the growth in the integrator's air cargo tonnage between 2010 and 2030, using the underlying assumptions from the baseline operations forecast. UPS' operations were forecast to increase from 19,400 in 2010 to 46,300 in 2030 at an annual growth rate of 4.5%.

Facility Requirements

Requirements for future air cargo facilities for all-cargo carriers, integrators, and belly cargo at c International Airport were calculated using planning factors based on industry planning standards and trends as well as existing facility utilization at the airport. Requirements were calculated for cargo buildings, cargo apron, automobile parking, and truck courts. The existing facility utilization ratios and planning factors used to calculate space requirements for each type of cargo were as follows:

- **Cargo Buildings**
    - *All-Cargo* – In the DFW master plan a planning factor of 1.5 ft^2 per annual U.S. ton of air cargo was used for domestic all-cargo and a planning factor of 1.75 ft^2 per annual U.S. ton of air cargo was used for international all-cargo. Existing facility utilization ratios were 10.09 ft^2 per annual U.S. ton of air cargo and 1.99 ft^2 per annual U.S. ton of air cargo for domestic all-cargo and international all-cargo, respectively. The URS Corporation noted that the existing utilization ratio of 10.09 ft^2 of building space per U.S. ton of domestic cargo handled represented underutilized space in domestic cargo facilities.
    - *Integrators* – A high ratio of 0.8 ft^2 per annual U.S. ton of cargo was used due to integrators' use of cargo buildings for sorting packages rather than storing packages. The existing facility utilization ratio was 1.55 ft^2 per annual U.S. ton of air cargo.
    - *Belly Cargo* – A planning factor of 1.75 ft^2 per annual U.S. ton of air cargo was used for belly cargo. The existing ratio was 2.24 ft^2 per annual U.S. ton of cargo.

    It should be noted that for all cargo types, future cargo building requirements used higher ratios than existing utilization ratios because it was assumed greater efficiency would be realized as air cargo volumes grew.

- **Cargo Apron**
    - *All-Cargo* – A planning factor of 2.5 ft^2 of apron space per square foot of building space was used for both domestic all-cargo and international all-cargo. The existing utilization ratio was 2.68 for international all-cargo and 2.14 for domestic all-cargo.
    - *Integrators* – A planning factor of 3.0 ft^2 of apron space per square foot of building space was used. The existing utilization ratio was 4.31.

  - *Belly Cargo* – A planning factor of 1.25 ft^2 of apron space per square foot of building space was applied only to account for existing apron area, since no additional apron areas for belly cargo were anticipated by 2030. The existing utilization ratio at the airport was 1.32.
- **Automobile Parking**
  - *All-Cargo* – A planning factor of 0.4 ft^2 of parking space per square foot of building space was used for both domestic all-cargo and international all-cargo. This ratio accounted for two lanes of parking and a drive through aisle for the length of the building. The existing utilization ratio was 0.28 for both types of cargo.
  - *Integrators* – Integrators typically have greater parking requirements due to the larger number of employees that work at their facilities. Therefore, a planning factor of 0.75 was used, compared with the existing utilization ratio of 0.82.
  - *Belly Cargo* – A planning factor of 0.3 ft^2 of parking space per square foot of building space was used. Similar to all-cargo, this ratio accounted for two lanes of parking and a drive through aisle for the length of the building. The existing utilization ratio was 0.25.
- **Truck Court**
  - *All-Cargo* – Based on the typical dimensions of truck courts (130 to 150 feet deep and extend the length of the cargo building) and the associated planning factor of 0.65 to 0.75 ft^2 per square foot of building space, depending on the type of cargo, URS used a planning factor of 0.75 for domestic cargo. The existing utilization ratio was 0.41. Because international cargo buildings tend to be wider, a lower factor of 0.65 was used for international cargo. The existing utilization ratio was 0.59.
  - *Integrators* – A planning factor of 1.0 was used for integrators for two reasons. First, integrator facilities typically have truck courts that extend around multiple sides of the building. Second, integrator facilities often provide adjacent trailer storage space.
  - *Belly Cargo* – A planning factor of 0.75 ft^2 per square foot of building space was used for the same reason identified for domestic all-cargo. The existing utilization ratio was 0.32.

URS subsequently calculated facility space requirements by applying the planning factors described above to the air cargo volume forecasts.

Recommended Air Cargo Development

An alternatives analysis identified air cargo development alternatives that would provide facilities capable of meeting the facilities requirements through 2030. Alternatives that could meet the demand projected in the baseline and alternate air cargo volume and aircraft operations forecasts were considered. Two preferred alternatives were selected. One preferred alternative was selected under the baseline forecast scenario and a second was selected under the alternate high-growth forecast scenario.

The preferred alternative selected under the baseline forecast scenario involved future development of 163 acres for international all-cargo and five acres for belly cargo. No additional acreage would be required for integrators and domestic all-cargo, as demand could be accommodated for these cargo types on existing sites.

The preferred alternative selected under the alternate high-growth forecast scenario was similar to the preferred alternative selected under the baseline forecast scenario. The primary difference was that the integrators would require an additional 28 acres to support forecast demand. Domestic all-cargo would require 19 acres for future development, since the expansion of integrator facilities would require the relocation of existing domestic all-cargo facilities. Belly cargo facilities would also be relocated and would require 18 acres for future development.

DONA ANA COUNTY AIRPORT – SANTA TERESA, NM
AIRPORT OVERVIEW

Dona Ana County Airport at Santa Teresa is a regional general aviation airport serving the New Mexican communities of Santa Teresa, Sunland Park, and Anthony; the western portion of El Paso County in Texas; and parts of northern Mexico. Owned and operated by Dona Ana County, the airport is located in the unincorporated community of Santa Teresa, which is 21 miles from downtown El Paso, Texas. Primary access to the airport is provided via Airport Road off of the Pete V. Domenici Highway (Highway 136). The airport occupies an approximate 1,700-acre site.

According to FAA 5010 data, Dona Ana County Airport experiences approximately 35,000 annual aircraft operations. The airport is equipped with a single runway, Runway 10/28, which measures 8,500 feet long by 100 feet wide. The runway has visual approaches at both ends. The airport is also supported by a general aviation passenger terminal building.

Dona Ana County Airport is classified as a general aviation airport in the NPIAS. The airport serves all types of general aviation, but focuses on business activity including jet and multi-engine aircraft. The airport also has daily air cargo service and is used extensively for flight training.

AIRPORT MASTER PLAN

The previous master plan for Dona Ana County Airport was completed in 1994. In 2006, the regional population was experiencing rapid expansion and there was significant public infrastructure and private development planned in the airport's environs. An update of the 1994 master plan was initiated in 2006 in order to coordinate the future development and effects of the airport with the region's growth. Dona Ana County selected WHPacific, Inc. to conduct the Master Plan Update, which was completed in March 2008.

Air Cargo Methodology

Existing Conditions

In 2006, scheduled air cargo service at Dona Ana County Airport was provided by Nord Aviation, which had a base of operations at the airport using one DC-6 and two DC-3 aircraft. Nord Aviation's cargo facilities consisted of 4,100 ft^2 of cargo building area; one truck dock; 3,250 ft^2 of landside support (employee parking, truck staging, and circulation); and 8,000 ft^2 of apron area. Cargo transported by Nord Aviation consisted primarily of automotive parts that were ferried between Mexico and El Paso International Airport. Nord Aviation operated an estimated 18 flights per month from Dona Ana County Airport with an average payload of 1.25 tons. Total air cargo tonnage at the airport in 2005 was 270 tons, the highest annual cargo tonnage reported at the airport since 1990.

Dona Ana County Airport possessed several characteristics that made it a desirable location for air cargo activity. These included convenient access from Interstate 10, location next to industrial parks, access to rail, and road accessibility to Ciudad Juarez's maquiladoras (manufacturing plants located in Mexico along the border with the U.S.), an uncongested Port of Entry in Santa Teresa, and a growing high tech industry sector in the State of Chihuahua. As a result, Dona Ana County had been preparing the airport for air cargo traffic for several years by constructing an apron, implementing improvements to Runway 10/28 and associated taxiways, and completing the first phase of a runway lengthening project that would allow the airport to accommodate heavy, wide-body cargo aircraft, such as the Boeing 767, Lockheed Martin L10-11, and Douglas DC-10.

Air Cargo Volume Forecasts

To prepare air cargo volume forecasts for Dona County Airport, WHPacific reviewed historical air cargo data and previous air cargo forecasts for the airport, international and domestic air cargo trends and forecasts prepared by Boeing and the FAA, and historical trends and future projections of population, employment, and earnings in the geographic areas that affect Dona Ana County Airport. WHPacific noted that the airport's air cargo history did not reflect volumes that might have occurred without the airport's runway length and strength limitations. WHPacific also noted that the air cargo industry was moving toward more fuel efficient aircraft due to the spike in fuel costs in 2006 and that wide-body air cargo aircraft were not likely to operate at Dona Ana County Airport. The air cargo volume forecast for the 2008 Master Plan Update examined Dona Ana County Airport's air cargo potential if runway constraints were removed.

In 2006, El Paso International Airport was the local air cargo airport serving the majority of Dona Ana County's air cargo market. Scheduled and express air cargo carriers used El Paso International due to its proximity to the large concentration of customers in El Paso. This fact, along with its close proximity to El Paso International, effectively precluded Dona Ana County Airport from attracting direct air cargo service by a major integrated express carrier. Air cargo activity at Dona Ana County Airport was therefore driven primarily by ad-hoc demand from Nord Aviation.

WHPacific conducted an analysis to determine the potential for air cargo to be diverted from El Paso International Airport to Dona Ana County Airport due to limitations of air cargo facilities at El Paso. To perform the analysis, a forecast of air cargo tonnage was prepared for El Paso International Airport. The forecast used growth rates of 6.1% for international cargo and 4.8% for domestic cargo. The forecast also used the following planning factors for air cargo building space and apron space:

- *Air Cargo Building Space* – Based on industry averages, 0.9 annual tons of cargo per square foot for was used for international cargo and 1.0 annual ton of air cargo per square foot was used for domestic cargo.
- *Apron Space* – An estimate of 2.0 annual tons per square foot was used.

Based on these growth rates and planning factors, air cargo tonnage at El Paso International was forecast to increase from 86,235 tons in 2005 to 198,467 tons in 2025; cargo building requirements were projected to increase from 78,744 ft^2 in 2005 (288,000 ft^2 existed in 2005) to 181,735 ft^2 in 2025 (a surplus of 106,265 ft^2); and apron space requirements were projected to increase from 40,962 yd^2 in 2005 (164,560 yd^2 existed in 2005) to 94,272 yd^2 in 2025 (a surplus of 70,288 yd^2). The analysis concluded that El Paso International's air cargo facilities were capable of accommodating forecast demand through 2025.

Although El Paso International Airport was the dominant air cargo airport in the region and had a surplus of air cargo facilities capacity, the potential still existed for Dona Ana County Airport to become a larger part of air cargo operations in the region if improvements to its runway were completed. WHPacific prepared a forecast of air cargo annual tonnage based on specific geographic areas that would benefit from improved air cargo service using a methodology applied in the 2003 New Mexico Airport System Plan. The geographic areas included the Santa Teresa market area, south-central New Mexico, and air cargo originating in Mexico that enters the U.S. via the Santa Teresa Port of Entry. The forecast assumed that 1) Dona Ana County Airport would benefit from air cargo demand originating and destined for the maquiladoras in Mexico and industries located in the State of Chihuahua, and 2) reliance of these maquiladoras and industries on air cargo would continue to increase during the planning period.

The methodology involved reviewing U.S. Border Crossing data for trucks carrying air cargo from Mexico through El Paso ports to be enplaned at El Paso International Airport and applying the same ratio of air cargo volume per truck (105 pounds) to truck crossings with a Mexico origination through the

Port of Santa Teresa. The analysis estimated that approximately 2,022 tons of air cargo crossed the border at the Port of Santa Teresa in 2006. It was assumed this air cargo tonnage would be included in future air cargo operations at Dona Ana County Airport once the improvements to Runway 10/28 were completed. WHPacific applied a growth rate of 3.8% to the Santa Teresa and south-central New Mexico geographic areas and a growth rate of 6.0% to cargo originating in Mexico and entering through the Santa Teresa Port of Entry. Each growth rates were taken from the Boeing World Air Cargo Forecast 2006-2007.

The forecast developed using this methodology estimated that 11,100 tons of enplaned air cargo could potentially be captured by Dona Ana County Airport by 2025. The tonnage captured per geographic area was as follows:

- 372 tons originating in the Santa Teresa area.
- 4,611 tons originating in south-central New Mexico.
- 6,188 tons originating in Mexico and entering the U.S. via the Santa Teresa Port of Entry.

This volume of air cargo equated to two Boeing 737-300SF freighter aircraft operations each business day at the airport by 2025.

Aircraft Operations Forecasts

Following a review of historical aircraft operations data and previous aircraft operations forecasts for the airport, WHPacific developed all-cargo aircraft operations forecasts through 2025 for Dona Ana County Airport. All-cargo operations at the airport were conducted by air taxi aircraft, which included Nord Aviation's DC-3 aircraft and a variety of chartered jets and turboprops. To forecast future activity by air taxi aircraft, a growth rate of 3.2% was used, which fell between the growth rate of 7.5% annual growth forecast by the FAA for turbine fixed wing aircraft hours flown nationwide and the 1.7% average annual growth shown in the FAA's Terminal Area Forecast for the airport. The growth rate of 3.2% was the FAA's national forecast for all general aviation and air taxi aircraft hours flown. Air taxi aircraft operations were forecast to increase from 3,197 in 2005 to 6,003 by 2025.

The forecast also considered the potential for future cargo flights at the airport by large all-cargo aircraft. The average aircraft size assumed for the forecast was a Boeing 737 freighter aircraft, which was capable of transporting 20 tons per departure. Operations by large freighter aircraft were assumed to begin with one departure per weekday at the airport in 2010, when improvements to Runway 10/28 were anticipated to be completed.

In all, aircraft operations by large all-cargo aircraft were projected to increase from 500 in 2010 to 1,000 in 2025 at an average annual growth rate of 4.7%. The forecast assumed large all-cargo aircraft would transport approximately 90% of the airport's cargo, with the remainder transported by air taxi aircraft (such as Nord Aviation's DC-3) carrying an average of three to four tons per departure.

Facility Requirements

The 2008 Master Plan Update identified future air cargo facility requirements for the near-term, mid-term, and long-term. Specific requirements were identified as follows, assuming a separate and dedicated area would be identified for cargo development and cargo grew as forecast:

- *Cargo Building Area* – 4,900 ft^2 in the near-term, 6,200 ft^2 in the mid-term, and 10,000 ft^2 in the long-term. Requirements were based on a planning factor of 0.90 tons of air cargo per square foot.

- *Truck Docks* – Two truck docks in the near-term, two in the mid-term, and three in the long-term. Requirements were calculated using 0.3 docks per 1,000 ft^2 of cargo building area.
- *Landside Support (Employee Parking, Truck Staging, Circulation)* – 3,900 ft^2 in the near-term, 4,950 ft^2 in the mid-term, and 8,000 ft^2 in the long-term. Landside support area was calculated as 80% of the cargo building size.
- *Apron Area* – 8,000 yd^2 in the near-term, 16,000 yd^2 in the mid-term, and 16,000 yd^2 in the long-term. Apron area was based on the estimated footprint of the largest aircraft times 3.0 for circulation (taxi lanes) and equipment staging.

Near–term land area requirements for cargo facilities were estimated at two acres and long-term land area requirements were estimated at four acres. For long-term development, the Master Plan Update recommended a separate and larger area be reserved that was centrally located and allowed for easy expansion.

Master Plan Recommendations

The 2008 Master Plan Update included an alternatives analysis that resulted in the selection of a preferred development plan for Dona Ana County Airport. The preferred development plan consisted of the following cargo-related recommendations:

- Extend Runway 10/28 length from 8,500 feet to 9,550 feet.
- Upgrade Runway 10/28 to an Airport Reference Code (ARC) C-III runway with a pavement strength rating of 95,000 pounds (dual wheel gear) and potential for precision-type instrument approaches to both ends.
- Construct a future crosswind runway that could be extended to 12,000 feet and made capable of serving heavy cargo aircraft in the future.
  Reserve a large lot at the far west end of the airport for an aviation tenant with significant development needs. The lot would have apron access and minimal taxi time to the Runway 10 threshold and the south end of the proposed crosswind runway.

GEORGE BUSH INTERCONTINENTAL AIRPORT – HOUSTON, TX

AIRPORT OVERVIEW

George Bush Intercontinental Airport is the primary commercial service airport serving the City of Houston and the Gulf Coast Region of Texas. Owned by the City of Houston and operated by the Houston Airport System (HAS), the airport is located approximately 23 miles north of downtown Houston and is accessible via Beltway 8 and U.S. Route 59. The airport occupies over 11,000 acres of land.

George Bush Intercontinental Airport experiences over 530,000 annual aircraft operations. There are five runways, four of which are equipped with instrument landing systems. Runway 08L/26R is 9,000 feet long by 150 feet wide, Runway 08R/26L is 9,402 feet long by 150 feet wide, Runway 09/27 is 10,000 feet long by 150 feet wide, Runway 15L/33R is 12,001 feet long by 150 feet wide, and Runway 15R/33L is 9,999 feet long by 150 feet wide. Three parallel Category III runways at the airport permit triple independent simultaneous all-weather flight operations. The airport is also supported by five terminal buildings and 880,000 ft^2 of cargo area.

George Bush Intercontinental Airport is a major commercial airline hub, one of the busiest airports in the world – ranked 6^{th} in operations in 2010 – and one of the United States' largest international hubs. The airport is currently served by 17 airlines, based both in the United States and internationally, which enplane over 20 million passengers annually. It is the largest hub for

United/Continental Airlines. In addition, more than 389,000 metric tons of air cargo was transported at the airport in 2010 by 11 all-cargo airlines.

AIRPORT MASTER PLAN

The City of Houston owns a system of three airports which are operated by the HAS – George Bush Intercontinental Airport, William P. Hobby Airport, and Ellington Field. Following the completion of a multi-billion dollar Capital Improvements Program initiated by the HAS in the late 1990s to update many of the facilities within the airport system, the HAS completed a Master Plan for George Bush Intercontinental Airport in 2006. The Master Plan, prepared by the consultant team of DMJM Aviation, Reynolds Smith & Hills (RS&H), and Leigh Fisher Associates, provides a blueprint for the facilities needed through 2025 for the airport to continue to meet the air transportation needs of the region.

Air Cargo Methodology

Existing Conditions

Air freight and air mail comprise the two types of air cargo at George Bush Intercontinental Airport. In 2002, the passenger and cargo airlines carried over 727 million pounds of freight and mail at the airport. Approximately 83% of the air cargo was freight, and the remaining 17% was mail. The passenger airlines carried 54% of the freight and 59% of the mail, while the cargo airlines carried the remaining 46% and 41%, respectively. Continental Airlines had the highest market share of the passenger airlines, with 41% of total air cargo. The cargo airlines with the highest market share were Federal Express and Airborne Express, accounting for 28% of the total air cargo at the airport in 2002.

When the Master Plan for George Bush Intercontinental Airport was finalized in 2006, the airport consisted of approximately 215 acres of air cargo space located in two areas of the airport – the northeast and central cargo areas. Construction of an East Cargo Complex had recently been completed and UPS had relocated its operations/sort hub to the airport from Ellington Field.

Air Cargo Volume Forecasts

Forecasts of air cargo activity at George Bush Intercontinental Airport were based on a review of historical trends at the airport, regional economic indicators, and evolving industry trends. Key assumptions included the following:

- Growth in air cargo will be primarily driven by local and national economic trends.
- Passenger airlines will continue to account for the majority of the air freight and mail activity.
- Local market consolidation (e.g., UPS's move to the airport from Ellington Field in 2003) will force more air cargo traffic through the integrated carriers' local hubs.
- Additional international air service will further concentrate forwarder consolidations at the airport, leading to more growth.

Based on these assumptions, the Master Plan projected the total volume of domestic and international air cargo to be carried by the passenger airlines and cargo airlines to grow from 780 million pounds in 2003 to 1.9 billion pounds in 2025. This represents an average annual growth rate of 4.2%.

Aircraft Operations Forecasts

Forecasts of air cargo aircraft operations were based on the forecasts of passenger activity and air cargo volume. Key assumptions used in preparing the forecasts included the following:

- Consistent with historical trends, air carrier operations would be approximately 2.0 times the number of commercial airline (passenger and cargo) aircraft departures.
- The average aircraft size for air carrier and regional/commuter service would increase.
- Average passenger and air cargo load factors would increase according to the fleet mix forecast prepared during the forecast effort.

Based on these assumptions and the fleet mix forecast developed in the Master Plan, forecasts of cargo pounds per departure were developed. The Master Plan projected total cargo air carrier operations to increase from 9,186 operations in 2003 to 17,000 operations in 2025, representing an average annual growth rate of 2.8%. Cargo commuter operations were projected to increase from 661 operations in 2003 to 4,000 operations in 2025, representing an average annual growth rate of 8.5%.

Air Cargo Demand Capacity

The Master Plan evaluated the warehouse, aircraft parking apron, truck docking area, and auto parking areas associated with the existing air cargo facilities at George Bush Intercontinental Airport to determine their capacity to adequately serve existing and forecast demand projected for 2005, 2010, 2015, and 2025. The methodology used ratios based on the comparison of gross facility areas with associated demand level. Recommended ratios were determined based on industry standards, interviews with airport staff, and on-site observations. The recommended ratios were compared with the actual ratios associated with the existing facilities and the projected demand from the air cargo forecasts.

Separate demand/capacity analyses were conducted for the all-cargo carriers, integrated carriers, and belly freight carriers operating at the airport due to their distinctly different types of operations. To evaluate the warehouse and aircraft parking apron areas for the all-cargo carriers and integrated carriers, the DMJM Aviation/RS&H team used a rate of 1.5 ft^2 of cargo building space for each annual ton of air cargo processed. This rate is based on a 1995 Airports Council International-North America (ACI-NA) survey of 75 domestic airports, which found the average warehouse utilization rate at airports handling air cargo is 1.5 ft^2. For the belly freight carriers, a rate of 2.0 ft^2 of warehouse space per annual ton of air cargo processed was used due to the methods used to process belly cargo and the inefficiencies associated with this type of air cargo operation. To evaluate the truck docking areas, ratios of 0.26, 0.62, and 0.25 ft^2 of truck docking area per square foot of existing warehouse space was used for the all-cargo carriers, integrated carriers, and belly freight carriers, respectively. To evaluate the auto parking areas, ratios of 0.59, 0.66, and 0.35 ft^2 of auto parking area per square foot of existing warehouse space was used for the all-cargo carriers, integrated express carriers, and belly freight carriers, respectively.

Based on the existing 215 acres of airport property dedicated to cargo operations and the projected air cargo demand, the demand/capacity analysis concluded that 215 additional acres of air cargo area should be reserved on the airport for cargo expansion through the planning period.

Air Cargo Development Plan

The Master Plan recommended a 215-acre site located near the existing northeast cargo area should be reserved for future air cargo development on George Bush Intercontinental Airport. The recommended site provides excellent airside access, apron space capable of supporting forecast activity levels, convenient ground access to major roadways, and the flexibility to expand as dictated by demand. Future development of the site would require acquisition of approximately 130 acres of land and construction of two access roads.

The Master Plan also identified a site for future off-airport air cargo development. The off-airport site is located near the existing northeast cargo area and provides a short commute for trucks between the two locations. It was envisioned the site would be occupied by freight forwarders.

KANSAS CITY INTERNATIONAL AIRPORT – KANSAS CITY, MO
AIRPORT OVERVIEW

Kansas City International Airport is the primary commercial service airport serving the City of Kansas City and surrounding region. Owned and operated by the City of Kansas City, the airport is located approximately 15 miles northwest of downtown Kansas City. Primary access to the airport is provided via Interstate 29 to the east and Interstate 435 to the west. The airport occupies over 10,000 acres of land.

Kansas City International Airport experiences approximately 147,000 annual aircraft operations (AIC-NA, 2010). The airport has two parallel runways and one crosswind runway, all of which are equipped with instrument landing systems. Runway 01L/19R is the primary runway, measuring 10,801 feet long by 150 feet wide. The airport is also supported by three passenger terminal buildings, which were renovated as part of the airport's Terminal Improvement Program that was completed in 2004.

Kansas City International Airport is classified as a medium hub airport in the NPIAS, offering non-stop service to 47 destinations. The airport is currently served by 10 passenger airlines which handled nearly 10.2 million passengers in 2010. Southwest Airlines is the airport's largest passenger airline, with Frontier Airlines using the airport as a hub and crew base. In addition, approximately 87,000 metric tons of air cargo was handled at the airport in 2010 by the passenger airlines and four cargo airlines (AIC-NA, 2010).

AIRPORT MASTER PLAN

In the mid-2000s, the City of Kansas City's Aviation Department and City Planning and Development Department determined that a new master plan was needed for Kansas City International Airport in order to accommodate the region's growing transportation needs and to maintain the airport's critical role as the region's economic engine. Landrum & Brown, Inc. was selected to complete the Master Plan for the airport, which was initiated in 2006 and adopted as the official guide for development at the airport by the City Council for the City of Kansas City in 2008. The Master Plan's primary goals were to revise the airport's ground transportation access links, improve airline and passenger efficiencies, and provide guidance regarding on-airport land use. The Master Plan's planning period was 2006 through 2025.

Air Cargo Methodology

Existing Conditions

In 2006, Kansas City International Airport was a unique major commercial service airport because of its surplus of existing cargo capacity and land available for expansion. The airport was in an enviable position because of its ability to accommodate virtually any forecast air cargo demand for the foreseeable future. In addition to the airport's unique expansion potential, the airport also enjoyed excellent interstate access due to its location at the center of the country. Mexico City Avenue, a dedicated cargo road located on-airport, provided access to Interstate 29, which in turn provided access to two major cross-country highways: Interstate 70 and Interstate 35.

Kansas City International Airport had four active commercial cargo terminals with immediate airside access. Three of the terminals were multi-tenant facilities and one terminal was a single-tenant facility. The airport's cargo facilities had a total capacity of approximately 251,000 ft^2 of warehouse space, 1.3 million square feet of apron area, 602 automobile parking spaces, 132 truck parking spaces, and 103 loading dock doors. There was also a USPS facility with airside access and an on-airport trucking terminal with no airside access. These facilities are described below:

- *Aeroterm* – The multi-tenant Aeroterm facility consisted of 46,347 ft^2 of warehouse space, 121,970 ft^2 of apron area, 107 automobile parking spaces, no truck parking spaces, and 16 loading dock doors. The Master Plan indicated that 100% of the apron space and office space were currently used, but only 70% of the warehouse space was used. The major tenant was UPS, which used 100% of the apron area but only 5,562 ft^2 of the warehouse space.
- *Haith and Company* – The multi-tenant Haith and Company facility consisted of 70,000 ft^2 of cargo space, 500,000 ft^2 of apron area, 103 automobile parking spaces, 30 truck parking spaces, and 38 loading dock doors. The warehouse space, ramp area, and office space were all 100% occupied. The major warehouse tenants were BAX Global with 20,000 ft^2, followed by Southwest Airlines and DHL with 15,000 ft^2 each.
- *AMB Property Corporation* – The multi-tenant AMB Property Corporation facility consisted of 50,000 ft^2 of warehouse space, 246,000 ft^2 of apron area, 250 automobile parking spaces, 20 truck parking spaces, and 20 loading dock doors. The Master Plan indicated that 72% of the warehouse space and 65% of the apron area was occupied. The largest warehouse tenants were Evergreen and UPS, with 11,500 ft^2 and 10,000 ft^2, respectively.
- *FedEx Express* – The single-tenant facility for FedEx Express included 85,000 ft^2 of warehouse space, 400,000 ft^2 of apron area, 142 automobile parking spaces, 82, truck parking spaces, and 29 loading dock doors. The facility was 100% occupied.
- *USPS* – The USPS occupied an old terminal with 66,000 ft^2 of building space and 35,000 ft^2 of ramp area. The Master Plan noted that the facility was still in operation because of the diversion of priority mail to FedEx Express and UPS and deferred deliveries to all-truck operations. It was unlikely that the facility could be used for any other cargo-related tenant due to the facility's condition and configuration.
- *Trucking Terminal* – Forward Air occupied a trucking terminal with 30,000 ft^2 of warehouse space, providing trucking services to the airport's non-integrated cargo operators. The terminal was the newest of the airport's cargo facilities.

In 2006, integrated cargo carriers FedEx Express, UPS, BAX Global, Airborne, and DHL handled approximately 92% of the airport's freight, with FedEx Express handling the largest percentage among these carriers at nearly 40%.

Air Cargo Volume Forecasts

The Master Plan prepared air cargo tonnage forecasts for Kansas City International Airport for the period 2006 through 2025. As part of the air cargo forecasts, Landrum & Brown considered a variety of factors and air cargo demand drivers. These included potential changes in air cargo security requirements following the events of September 11, 2001, off-airport cargo development, historical trends in air cargo tonnage at the airport, consumer demand, business investment, and modal competition.

After evaluating these factors and demand drivers, several assumptions were used to develop the forecasts of air cargo tonnage. First, it was assumed that air cargo growth would occur over the forecast period as local and national population, employment, and income grew. Second, Landrum & Brown deemed it unlikely that the airport would secure international cargo routes during the planning period, and therefore would not experience the higher growth rates in international cargo projected by industry analysts. For domestic cargo, Landrum & Brown believed the national and regional hubs of the integrated carriers were more likely to experience the higher growth rates forecast for domestic cargo. Lastly, Landrum and Brown reviewed long-term forecasts of air cargo activity prepared by BACK Aviation Solutions (BACK) and Boeing. BACK Aviation Solutions provides strategic and technical consulting and data information services to the aviation industry. BACK projected domestic cargo in North America would grow at a rate of 1.4% through 2015, while Boeing projected growth at a rate of 4.1% through

2023. Landrum and Brown assumed the long-term growth rate at Kansas City International Airport would fall between the BACK and Boeing growth rates. Based on these assumptions and Landrum and Brown's experience, it was determined that a growth rate of 2.1% would be used to forecast air cargo growth in the Master Plan. For the period 2006 through 2025, air cargo was forecast to increase from 134,975 metric tons to 204,900 metric tons. Approximately 11% of the total air cargo tonnage was projected to be belly cargo throughout the forecast period.

Aircraft Operations Forecasts

Forecasts of all-cargo operations were prepared for the Master Plan based on the air cargo volume forecasts and the airport's existing and projected aircraft fleet mix. Landrum and Brown projected that an additional daily medium-sized freighter would be added each year. Operations by aircraft type were forecast to grow as follows:

- *Wide-body Jet* – Increase from 23% of cargo operations in 2005 to 28% in 2025.
- *Narrow-body Jet* – Decline from 52% in 2005 to 49% in 2025.
- *Turbojet* – Remain constant as a percent of total operations.
- *Turboprop* – Decrease from 15% of cargo operations in 2005 to 13% in 2025.

Overall, all-cargo operations were forecast to increase from 9,864 operations in 2005 to 13,940 operations in 2025 at a growth rate of 1.7%.

Facility Requirements

The Master Plan concluded that no additional air cargo facilities were required at Kansas City International Airport throughout the planning period. Landrum and Brown arrived at this conclusion after considering a variety of factors. These factors included the following:

- *Historical and Forecast Air Cargo Tonnage* – Air cargo tonnage decreased almost every year between 1999 and 2005, falling from 161,625 metric tons in 1999 to 136,889 metric tons in 2005. Air cargo tonnage forecast for 2025 was only 25% greater than the airport's historical peak year of 1999.
- *Geography* – Kansas City's geography, namely its central location and excellent interstate access, is more conducive to cargo transport by trucking than by air.
- *Regional Economy* – The Kansas City region was primarily a traditional agricultural economy that lacked industries requiring the time-sensitive delivery of goods. The region was also sparsely populated, which did not favor a regional gateway operation by a cargo carrier.
- *Industry Planning Guidelines* – Landrum and Brown used the International Air Transport Association's (IATA) Airport Development Reference Manual to evaluate the airport's existing and future cargo facility capacities. Based on the airport's existing 251,347 ft^2 of cargo terminal building space and IATA's planning factor of 0.93 metric tons of cargo per square foot of cargo terminal building space for a cargo tenant using an average level of automation in its operations, Landrum and Brown determined that the airport's existing cargo facilities could accommodate approximately 226,000 metric tons of cargo, which was more than the 204,900 metric tons forecast for 2025. IATA's manual also provided a planning guideline for ramp space. This guideline stated that "the apron size for all cargo facilities lies in the range of four to five times that of the cargo terminal building area." Kansas City International Airport had approximately 1.3 million square feet of ramp, which meant that the airport had a ratio greater than five times the ramp space to cargo terminal building area.

Master Plan Recommendations

Although the Master Plan did not identify the need for additional cargo facility capacity at Kansas City International Airport, Landrum and Brown noted the importance of protecting the airport's existing concentrated cargo area for future growth by its cargo tenants and for the possible entry of a new major cargo carrier during the planning period. Accommodating future air cargo growth would not be an issue due to the airport's abundance of developable land.

MEMPHIS INTERNATIONAL AIRPORT – MEMPHIS, TN
AIRPORT OVERVIEW

Memphis International Airport is the primary commercial service airport serving the City of Memphis and the surrounding eight-county region, which includes Fayette, Shelby, and Tipton counties in Tennessee; DeSoto, Marshall, Tate, and Tunica counties in Mississippi; and Crittenden County in Arkansas. Owned and operated by the Memphis-Shelby County Airport Authority (MSCAA), the airport is located approximately seven miles southeast of downtown Memphis and four miles north of the Tennessee – Mississippi state line. Primary access to the airport is provided via Interstate 240, Plough Boulevard, and Tchulahoma Road. The airport occupies an approximate 5,000-acre site.

Memphis International Airport experiences approximately 340,000 annual aircraft operations. The airport has four runways, all of which are equipped with instrument landing systems. Runway 18R/36L is 9,320 feet long by 150 feet wide, Runway 18C/36C is 11,120 feet long by 150 feet wide, Runway 18L/36R is 9,000 feet long by 150 feet wide, and Runway 09/27 is 9,000 feet long by 150 feet wide. The airport is able to operate in all weather conditions, handles all types of aircraft, and is outfitted with a surface movement guidance system allowing flight operations down to a runway visual range of 300 feet.

Memphis International Airport is unique in that it is one of the few dual-purpose hubs in the United States. The airport is the world headquarters of FedEx Express and the world's second busiest cargo airport, handling 4.2 million U.S. tons of cargo in 2010. FedEx Express operates its primary overnight package sorting facility at the airport and transported approximately 98.7% of all cargo handled at the airport in fiscal year 2010. A total of eight cargo airlines currently serve the airport. Memphis International Airport is also a major transfer hub for its largest passenger airline, Delta Air Lines. In all, the airport is served by four major and 15 regional scheduled passenger airlines which together enplaned more than ten million passengers in 2010.

AIRPORT MASTER PLAN

The MSCAA completed a Master Plan for Memphis International Airport in 2000 and subsequently implemented the majority of the recommendations over the ensuing years. The most significant changes at the airport during this period included the relocation of the Tennessee Air National Guard's facilities to the southeast corner of the airport to accommodate FedEx Express' expansion on the north side of the airport; development of a consolidated ground transportation center; the expansion of Concourse A to accommodate a regional jet facility; secure passenger walkways linking Concourses A, B, and C; and construction of the "East Cargo" development. The MSCAA initiated a Master Plan Update in 2007 due to significant FedEx Express growth and expansion since 2001, which necessitated an updated assessment of the airfield's long-term capacity. The airport's passenger terminal was also nearing the end of its design life, which required a new long-term vision for the airport. The MCSAA contracted Jacobs Consultancy to conduct the Master Plan Update, which was completed in 2010.

Air Cargo Methodology

Existing Conditions

An inventory of Memphis International Airport's existing conditions related to air cargo facilities indicated five areas on the airport dedicated to cargo operations. These included the following:

- *FedEx Express* – FedEx Express' Super Hub sorting facility, aircraft parking aprons, and ancillary support facilities were primarily located in the north airfield, both north and south of Runway 09/27. The Master Plan Update did not formally inventory FedEx Express facilities and did not include planning related to those facilities, since FedEx Express is responsible for its own planning and is located on private property adjacent to MCSAA property.
- *UPS* – The Oakhaven Distribution Center, a 300,000 ft^2 sorting hub, occupied 84 acres of land on the eastern airfield with an adjacent 9-acre aircraft parking apron. An additional 50 acres was located south of the Oakhaven Distribution Center for future expansion by UPS.
- *USPS* – The USPS operated a 22,000 ft^2 sort facility located on a 4-acre site south of the passenger terminal.
- *General Air Cargo* – A 390,000 ft^2 air cargo apron was located north of the passenger terminal apron. Located west of the air cargo apron were four air cargo warehouses that were originally intended for use by air cargo tenants. However, these warehouses were no longer used for air cargo since many of the cargo carriers that use the air cargo apron operate "through-the-fence" and use off-airport sorting and distribution facilities.
- *Cargo Central* – In 2008, the MSCAA completed construction on Phase I of a new 70-acre multi-user air cargo complex. Phase I provided users with 15 acres of aircraft parking apron; 36,000 ft^2 of office and warehouse space; direct access onto the local roadway system; secure airfield access; customs, security, and agricultural screening services; and a Land rack and Westpac refueling facility. At ultimate build-out, the site would include 250,000 ft^2 of warehouse space and 30 acres of aircraft parking apron.

Air Cargo Volume Forecasts

As noted above, Memphis International Airport is the world headquarters for FedEx Express. Because FedEx Express handles the vast majority of the air cargo at the airport through hub shipments, two different air cargo volume forecasts were prepared. One forecast was prepared exclusively for FedEx Express based on market drivers unique to that carrier. A separate forecast was prepared for the other cargo carriers at the airport that handle local shipments, such as UPS, DHL, and potential carriers using Cargo Central. Baseline, low-growth, and high-growth scenarios for both forecasts were developed based on assumptions related to FedEx Express' overnight express traffic, FedEx Express' future focus on the international market, other cargo carriers' growth based on the local Memphis economy, and future growth of the heavy freight and international markets controlled by the freight forwarding and third party logistics providers. Following the FAA's review of the forecasts during the approval process, it was determined only the baseline scenario would be used in the Master Plan Update. In the baseline scenario, FedEx Express air cargo tonnage was forecast to increase from nearly 3.8 million in 2007 to nearly 4.1 million at a growth rate of 2.1%. Air cargo tonnage handled by other cargo carriers was forecast to increase from nearly 70,000 in 2007 to over 172,000 in 2027 at an annual growth rate of 4.6%. Total air cargo tonnage for all carriers was forecast to increase from more than 3.8 million in 2007 to nearly 5.9 million in 2027 at an annual growth rate of 2.2%.

Aircraft Operations Forecasts

Baseline, low-growth, and high-growth forecasts of air cargo aircraft operations were prepared based on a review of historical air cargo activity, industry trends, regional economic conditions, and other key factors that affect air cargo demand. As for the air cargo volume forecasts, only the baseline scenario was used in the Master Plan Update. In the baseline scenario, total air cargo aircraft operations were forecast to increase from 133,580 in 2007 to 157,800 in 2027 at an annual growth rate of 0.8%.

Facility Requirements

The Master Plan Update estimated air cargo facility requirements necessary to meet demand levels through 2027. Estimated requirements were prepared for warehousing and storage, aircraft parking apron space, landside access and vehicle parking, and land/site location based on best practices within the cargo industry. Each is discussed below. As noted above, FedEx Express is responsible for its own facility planning and as such, the Master Plan Update did not include facility requirements for this carrier.

- *Cargo Warehouse and Storage Requirements* – The Master Plan Update utilized a ratio of 1.25 annual tons of air cargo per square foot of warehouse space to estimate future warehouse and storage requirements for most of the cargo carriers at Memphis International Airport. This ratio was applied to the air cargo volume forecast to arrive at estimated facility requirements for 2012, 2017, and 2027. UPS presented a unique situation and required a different methodology for estimating its future warehouse and storage requirements. UPS utilizes a relatively large amount of warehouse space for the volume of air cargo it handles at the airport (300,000 ft^2 of warehouse space to process 27,000 tons of air cargo in 2007). This is due to the large amount of ground-based activity processed through their warehouse space. The Master Plan Update determined that UPS would require incremental increases in warehouse space to handle anticipated growth in air cargo and ground shipments. Specifically, warehouse and storage requirements were projected to increase from 300,000 ft^2 in 2007 to 600,000 ft^2 in 2027.
- *Aircraft Parking Apron Space* – For the Master Plan Update's 2007 baseline, Memphis International Airport provided approximately 400,000 ft^2 of aircraft parking space on the UPS apron and 650,000 ft^2 at Cargo Central. To estimate future apron space requirements, Jacob Consultancy used the projected aircraft fleet mix and the following assumptions:
    - A conservative peak four-hour period was used to estimate current demand during the design day.
    - Increases in required aircraft parking positions and increases in average day peak month air cargo operations would be proportional.
    - Approximately 40,000 ft^2 of apron space would be required for each air carrier aircraft parking position.
    - Approximately 15,000 ft^2 of apron space would be required for each feeder aircraft parking position.

Based on these assumptions, the airport's existing 10 air carrier and two feeder aircraft parking positions would need to increase to 19 air carrier and six feeder aircraft parking positions in 2027. This corresponds to 1,250,000 ft^2 of apron space required in 2027.

- *Landside Access and Vehicle Parking* – The Master Plan Update discussed general planning guidelines in the air cargo industry for truck staging areas and employee/customer parking spaces. For truck staging areas, 10 docks are planned for each 20,000 ft^2 of warehouse space. For employee/customer parking, 20 spaces are recommended for every 10,000 ft^2 of warehouse space. The Master Plan Update reiterated, however, that these are guidelines only and each future building would be designed differently based on modifications to the guidelines.
- *Location Requirements* – Land/site location requirements in the Master Plan Update included the following:
    - Land east of the airfield should be reserved for future expansion of air cargo facilities in order to minimize interference with the passenger terminal complex and maximize access for vehicular/truck activity.

- Consolidation of future air cargo facilities is recommended in order to preserve airport land for commercial development.
- Cross-dock and distribution facilities should be an integral component of future development within the Cargo Central complex.

Master Plan Recommendations

The Master Plan Update recommended a future on-airport land use plan for the airport. Recommendations for the two primary on-airport areas related to air cargo included the following:

- *FedEx Express* – Although facility requirements for FedEx Express were not estimated in the Master Plan Update, it was determined that FedEx Express would likely need to expand its land envelope at some point during the 20-year planning period, based on its historical growth of on-airport leased areas and its forecast activity levels. This would require relocation of leased areas adjacent to FedEx Express' existing facilities. The Master Plan Update identified potential areas for FedEx Express expansion and the facilities that would need to be relocated as a result.
- *East Side* – The Master Plan Update recommended that the existing air cargo areas accommodating UPS and Cargo Central should remain in their existing land use envelopes.

OAKLAND INTERNATIONAL AIRPORT – OAKLAND, CA

AIRPORT OVERVIEW

Along with San Francisco International Airport and Norman Y. Mineta San Jose International Airport, Oakland International Airport is one of three international airports serving the San Francisco Bay Area. Owned and operated by the Port of Oakland, the airport is located approximately 6.5 miles from downtown Oakland. Primary access to the airport is provided via Interstate Highway 880, Hegenberger Road, and 98th Avenue to Airport Drive. The airport occupies an approximate 2,600-acre site.

Oakland International Airport experiences approximately 220,000 annual aircraft operations (AIC-NA, 2010). The airport has four runways, two of which are equipped with instrument landing systems. Runway 11/29 is the primary runway, measuring 10,000 feet long by 150 feet wide. Oakland International Airport is also supported by two passenger terminal buildings, one of which was recently expanded and remodeled as part of the airport's $300 million Terminal Improvement Program. The airport also broke ground on a new air traffic control tower in 2010, which opened in 2013.

Oakland International Airport is classified as a medium hub airport in the NPIAS. The airport is currently served by ten airlines, nine domestic and one international, which handled nearly 9.9 million passengers in 2010. Southwest Airlines uses the airport as a focus city and is the airport's largest airline. In addition, nearly 511,000 metric tons of air cargo was handled at the airport in 2010 by the passenger airlines as well as cargo carriers including FedEx Express, UPS, and Ameriflight. FedEx Express has a regional cargo hub at the airport (AIC-NA, 2010).

AIRPORT MASTER PLAN

The Airport Development Program (ADP) served as Oakland International Airport's planning guidance document from the late 1980s to the mid-2000s. The ADP included several improvement and enhancement projects designed to accommodate increased passenger demand and enhance the airport's reputation for convenience and on-time reliability, including the Terminal Improvement Program. Because of the airport's need for a new planning document to provide development and land use guidance over a twenty year period, a new master plan was initiated in 2004. The master plan process included community participation as a result of various agreements settling litigation over environmental documents related to the ADP. The Port of Oakland's Aviation Planning and Development staff prepared the master plan with assistance from other Port of Oakland staff as well as from specialty consultants for airfield simulation, aircraft noise analysis, and graphics. A Stakeholder Advisory Committee reviewed the technical work throughout the study. The master plan was finalized in 2006.

Air Cargo Methodology

Existing Conditions

In 2004, Oakland International Airport was the 12th busiest airport in the United States in terms of air cargo tonnage, according to Airports Council International – North America. The airport handled approximately 700,000 metric tons of cargo in 2004, with FedEx Express handling over 80% of this volume. UPS was the second-largest cargo carrier at the airport, handling approximately 15% of the cargo tonnage in 2004. Other cargo carriers included ABX Air/DHL, Ameriflight, and some smaller air cargo feeders.

The airport's cargo facilities were located in two areas of the airport. South Field, defined as the airport area south of Ron Cowan Parkway, consisted of approximately 104 acres dedicated to air cargo. The FedEx Express Metroplex (FedEx Express' west coast hub) was the largest of the cargo facilities in South Field. North Field, defined as the airport area north of Ron Cowan Parkway, included approximately 30 acres of cargo facilities for ABX Air/DHL, USPS, and Ameriflight.

Air Cargo Volume Forecasts

Forecasts of air cargo tonnage were prepared through 2025 based on the following methodology:

- Used 2003 as the base year for air cargo tonnage.
- Considered potential markets for future air cargo growth at Oakland International Airport.
- Identified an appropriate air cargo growth scenario for the master plan based on the historical cargo growth rates at Oakland International Airport, San Francisco International Airport, and Norman Y. Mineta San Jose International Airport and the maturity of the air cargo market at Oakland International.

Following a review of historical air cargo activity at the Bay Area airports and air cargo forecasts from the 2000 Regional Airport System Plan (RASP) and the ADP's 2003 Supplemental Environmental Impact Report (SEIR), the growth rates from the historical data, RASP, and SEIR were used to develop forecast scenarios of future cargo tonnage for Oakland International Airport. The growth rates used in this analysis ranged from 3.59% to 7.84%. It was determined from this analysis that the low growth rate of 3.59% would be used to project future cargo tonnage at the airport.

The growth rate of 3.59% represented the historic air cargo growth observed at the Bay Area's airports since 1990 and was selected for several reasons. First, the previous air cargo forecasts from the RASP and SEIR were based on rapid air cargo growth at the airport between 1990 and 1998 and did not consider maturing of air cargo activity at the airport that resulted in decreased air cargo activity between 1998 and 2004. The RASP and SEIR used growth rates ranging from 4.52% to 7.84%. Second, it was determined that Oakland International Airport would be unable to capture further market share from other Bay Area airports, since the airport already handled approximately half of the Bay Area's total cargo tonnage. Lastly, the Port of Oakland decided that it would not pursue an aggressive marketing strategy to encourage rapid air cargo growth at the airport. Air cargo tonnage was therefore forecast to increase from 0.7 million annual tons (MAT) in 2004 to 1.5 MAT in 2025.

Aircraft Operations Forecasts

Air cargo operations forecasts were prepared through the development of Average Annual Day (AAD) air cargo schedules for 2003 and 2010; however, due to the uncertainty of long-term forecasts, air cargo operations were not developed beyond 2010. AAD was used rather than average day peak month (ADPM) to develop the schedules, because, unlike airline passenger activity, air cargo volumes are relatively constant throughout the year. To develop the current (2003) air cargo schedule based on 0.7 MAT, the 2000 0.8 MAT air cargo flight schedule and fleet mix from the ADP environmental review documents were used to create a baseline of the airport's air cargo activity, including the number of arrivals and departures by the air cargo airlines and the specific aircraft types used. Adjustments to these data were then made to reflect the air cargo operations and fleet mix observed in 2003. The total number of daily air cargo operations in the 2003 schedule for the master plan was 156 (102 at South Field and 54 at North Field).

A 2010 0.9 MAT air cargo schedule was developed by interpolating between the 2003 flight schedule and a 2010 1.4 MAT flight schedule from the ADP environmental review documents. The total number of air cargo operations in the 2010 schedule for the master plan was 164 (102 at South Field and 62 at North Field). This schedule reflected the air cargo airlines fleet mix assumed for the 2010 1.4 MAT flight schedule from the ADP environmental review documents.

Facility Requirements

The master plan did not include an air cargo facility requirements analysis.

Master Plan Recommendations

The master plan recommended modest expansions of air cargo tenant facilities at their existing or relocated facilities due to the Port of Oakland's decision not to pursue an aggressive air cargo development program. The following four areas on the airport were identified for potential air cargo development to accommodate forecast demand:

- Area 1, North Field – Provided approximately 180 acres for air cargo development.
- Area 2, Central Basin – Provided approximately 330 acres for air cargo development.
- Area 3, south of Ron Cowan Parkway and north of the FedEx Express Metroplex – Allowed for modest expansion of FedEx Express' facilities.
- Area 4, the existing air cargo area at South Field and the Oakland Maintenance Center site – Allowed for modest expansion and relocation of existing air cargo facilities or both.

Based on the low growth in air cargo tonnage and air cargo operations forecast for the airport, Areas 3 and 4 were selected for future air cargo development. Relocation of existing cargo facilities within Area 4 was recommended in order to accommodate potential new terminal development.

PIEDMONT TRIAD INTERNATIONAL AIRPORT – GREENSBORO, NC

AIRPORT OVERVIEW

Piedmont Triad International Airport is the primary commercial service airport serving the Piedmont Triad Region, which encompasses the 12 North Carolina counties of Surry, Stokes, Rockingham, Caswell, Yadkin, Forsyth, Guilford, Alamance, Davie, Davidson, Randolph, and Montgomery and the six southern Virginia counties of Carroll, Floyd, Patrick, Franklin, Henry, and Pittsylvania. Owned and operated by the Piedmont Triad Airport Authority, the airport is located approximately 10 miles west of downtown Greensboro; 17 miles east of Winston-Salem; and, 10 miles north of High Point. Primary access to the airport is provided via Bryan Boulevard. The airport occupies an approximate 4,000-acre site.

Piedmont Triad International Airport experiences approximately 90,000 annual aircraft operations (AIC-NA, 2010). The airport has two parallel runways and one crosswind runway, all of which are equipped with instrument landing systems. Runway 5R/23L is the primary runway, measuring 10,001 feet long by 150 feet wide. Construction of Runway 5L/23R was completed in 2009, with the runway becoming operational in January 2010. The airport is also supported by a passenger terminal building centrally located north of Runway 5R/23L and south of Runway 5L/23R.

Piedmont Triad International Airport is classified as a small hub airport in the NPIAS, offering non-stop service to 13 domestic destinations. The airport's six mainline airlines and associated regional airlines handled nearly 1.7 million passengers in 2010. In addition, more than 86,000 metric tons of air cargo was transported at the airport in 2010(AIC-NA, 2010).

AIRPORT MASTER PLAN

The last Master Plan for Piedmont Triad International Airport was completed in 1994. A Master Plan Update was initiated in 1997 but was suspended in 1999 due to FedEx Express' selection of the airport for a new Mid-Atlantic hub. The Piedmont Triad Airport Authority recognized that the development of this hub would require detailed planning, design, environmental review, and permitting for major improvements to the airfield and surface transportation system.

After the suspension of the 1997 Master Plan Update, several improvements were completed at the airport. A few of the more significant improvements included construction of the 9,000-foot parallel Runway 5L/23R and associated taxiway system, passenger terminal expansion to accommodate new passenger and baggage screening facilities, construction of the FedEx Express Mid-Atlantic Hub, expansion of the passenger terminal's north concourse, construction of a cross-field taxiway system, construction of Honda Aircraft Company's Headquarters and HondaJet Research and Development Facility, and the realignment of Bryan Boulevard. The Piedmont Triad Airport Authority decided in 2007 that because these and other improvements were completed or nearing completion, the time was right to plan for future growth of the airport. URS Corporation was selected to prepare a Master Plan Update, which was initiated in late 2007 and finalized in September 2010. The Master Plan Update was conducted for the following five primary reasons:

- Respond to anticipated changing user demand and economic development opportunities,
- potential extended timelines to develop needed airport improvements,
- need for the development of a strategic long-range visioning approach to airport planning for Piedmont Triad International Airport,
- strategic airport master planning considerations (beyond the typical 20-year planning horizon used in airport master plans), and
- considerations of FAA's Next Generation Air Transportation System (NextGen).

Air Cargo Methodology

Existing Conditions

All-cargo historically accounted for the vast majority of cargo handled at Piedmont Triad International Airport. During the master planning process, five dedicated air cargo operators provided all-cargo service at Piedmont Triad International Airport. These operators included FedEx Express, DHL Express, Mountain Air Cargo, TradeWinds, and UPS. The passenger airlines provided a varying amount of belly cargo services. The Master Plan Update included the following inventory of air cargo building space and tenants:

- *FedEx Express Mid-Atlantic Sort Hub Facility* – FedEx Express' Mid-Atlantic Sort Hub Facility opened in 2009. The main sort building consisted of 317,200 ft^2 of space.
- *Mountain Air Cargo* – Mountain Air Cargo provided express cargo flight services to FedEx Express using Cessna 208 Caravan aircraft.
- *DHL Express* – DHL Express leased 14,950 ft^2 of space in Air Cargo Building #3.
- TradeWinds – TradeWinds provided domestic and international air cargo transport services. It leased 24,300 ft^2 of space within Hangar B, which was located on the south side of the airport.
- *UPS* – UPS' operations at the airport consisted of express overnight cargo and ground cargo. The air cargo operation was located in Air Cargo Building #2 and consisted of 3,276 ft^2 of space. UPS operated a single Douglas DC-8-71CF/-73CF at the airport.
- *Belly Cargo Airlines* – Delta and Continental airlines leased 3,780 ft^2 and 7,560 ft^2 of space, respectively, within Air Cargo Building #2. Comair leased 1,920 ft^2 within Air Cargo Building #1. These airlines used their leased space for storage and maintenance of ground service equipment.
- *USPS* – The USPS leased 12,001 ft^2 of space within Air Cargo Building #2.
- *Ramp Services* – Three separate ground handlers leased a total of 6,972 ft^2 of space within Air Cargo Building #2. These tenants included Aviation Repair Technology, Quantem, and Jetstream.
- *TIMCO* – TIMCO leased 10,000 ft^2 of space within Air Cargo Building #3 for its Maintenance, Repair, and Overhaul (MRO) operation.

In all, the airport's air cargo facilities consisted of 495,517 ft^2 of building space.

Air Cargo Volume Forecasts

Jacobs Consultancy, in association with URS Corporation, developed forecasts of all-cargo volumes for the period 2007 to 2030 for the Master Plan Update. Jacobs Consultancy noted that there would be significant growth in all-cargo volumes at Piedmont Triad International Airport as Phase I of FedEx Express' sort hub facility began operations. Because future expansion of the facility would occur, resulting in the accommodation of future, unknown cargo volumes by FedEx Express and Mountain Air Cargo, only all-cargo volumes for the airport's other all-cargo carriers were forecast in the Master Plan Update.

To develop the all-cargo forecasts, Jacobs Consultancy reviewed forecasts for the U.S. domestic air cargo industry prepared by Boeing and Airbus. Boeing and Airbus forecast U.S. domestic air cargo to grow at a rate of 2.9% and 3.3%, respectively, over a twenty year period. These two growth rates were averaged to arrive at a growth rate of 3.1%, which was used to forecast all-cargo tonnage at the airport. Based on this methodology, total all-cargo tonnage (less FedEx Express and Mountain Air Cargo) was projected to increase from 27,082 metric tons in 2007 to 54,655 metric tons in 2030.

For belly cargo tonnage, Jacobs Consultancy based the forecast on the Master Plan Update's forecast of passenger aircraft operations (specifically the anticipated passenger airline fleet mix). Historical data showed that belly freight tonnage declined at the airport between 1999 and 2007 due to the airlines' shift from air carrier to regional jet aircraft, new belly cargo restrictions following the events of September 11, 2001, and the growing trend for air cargo to be shipped by express carriers such as FedEx Express and UPS rather than freight forwarders that contracted with airlines. Jacobs Consultancy anticipated that belly cargo volumes would continue to decline because the passenger aircraft operations forecast indicated growth only in the commuter segment by turboprop aircraft that lack significant cargo capabilities. For facility planning purposes, however, Jacobs Consultancy assumed that the airport's existing belly cargo volumes (approximately 900 metric tons per year) would continue through the planning period.

Lastly, the Master Plan Update did not forecast future mail tonnage due to the significant decline in tonnage handled at the airport since 2000 caused by restrictions on mail weighing more than 16 ounces following the events of September 11, 2001, the USPS' contract with cargo carriers to transport mail that was previously transported by the passenger airlines, and the shift in the fleet mix of passenger airlines from air carrier to regional jet aircraft.

Aircraft Operations Forecasts

Forecasts of all-cargo aircraft operations, including operations by FedEx Express and Mountain Air Cargo, were prepared for the Master Plan Update. To forecast operations by FedEx Express and Mountain Air Cargo, Jacobs Consultancy used estimates of aircraft operations with the new sort hub facility obtained from studies relating to the Environmental Impact Statement for Runway 5L/23R. These studies estimated that FedEx Express and Mountain Air Cargo operations would increase from 1,696 in 2007 to 12,350 in the first phase of the hub operation. Following expansion of the hub operation, operations were forecast to increase to an annual level of 32,760.

To forecast aircraft operations by the other all-cargo carriers, Jacobs Consultancy calculated historical ratios of cargo tonnage per aircraft operation and applied adjusted ratios to forecasted all-cargo tonnage. Because the historical ratio in recent years was approximately 15 tons per operation, this ratio was used for the forecast. All-cargo operations by the cargo carriers other than FedEx Express and Mountain Air Cargo were projected to increase from 1,974 operations in 2007 to 3,644 operations in 2030. Total all-cargo aircraft operations at the airport were forecast to increase from 5,090 in 2007 to 36,404 in 2030 at an average annual growth rate of 8.9%.

Facility Requirements and Master Plan Recommendations

There were six existing air cargo facilities located on Piedmont Triad International Airport. As explained previously, these facilities totaled 495,517 ft^2 and included Air Cargo Buildings #1, #2, and #3, TradeWinds Cargo Building, the former UPS-SCS building, and FedEx Express' Main Sort Building. Because of declining belly cargo and mail tonnage at the airport since 2000, approximately 50% of these facilities' capacity was being used for air cargo purposes.

Jacobs Consultancy explained that Air Cargo Buildings #2 and #3 would need to be demolished due to current airfield improvements and FedEx Express' future expansion of its hub operation. It was recommended that 71,280 ft^2 of building space be replaced "in-kind" in order to accommodate each building's existing tenants. Air Cargo Building #1 would be demolished due to its age and physical condition and would be replaced "in-kind" by constructing a new facility totaling 2,400 $ft^{2.}$ Lastly, the Piedmont Triad Airport Authority used storage space located in Air Cargo Buildings #1, #2, and #3 that was recommended to be replaced by constructing one building totaling 29,400 ft^2. The size of each of the replacement facilities was calculated by increasing each tenant's existing square footage by 20%. In all, a total of 103,080 ft^2 of replacement cargo building space would need to be constructed.

As noted above, one of the reasons the Piedmont Triad Airport Authority initiated the Master Plan Update in 2007 was to look beyond the typical 20-year planning window traditionally used in airport master plans. The Airport Authority desired insight regarding how and in which geographic direction the airport might grow over a 21 to 50 year period. The Master Plan Update therefore included long-range visioning and planning guidance provided by Dr. John D. Kasarda, Chief Executive Officer of Aerotropolis Business Concepts who provided his expertise on "airport cities", aviation infrastructure, economic development, and competitiveness. The concept of the "Aerotropolis," is defined as a new urban form emerging at airports around the world in which aviation-oriented businesses and associated residential and retail development are drawn to the airport environs and the transportation corridors radiating from them.

In the Master Plan Update, Dr. Kasarda noted the unique opportunity the Piedmont Triad Airport Authority faced in terms of the airport's long-term development. With the opening of the FedEx Express Mid-Atlantic Sort Hub Facility and increased airport capacity created by the construction of Runway 5L/23R, there was likely to be significant on- and off-airport development not witnessed previously by the Piedmont Triad Airport Authority. Both air-intensive industries and other sectors would increasingly consider the airport environs an attractive site for relocation or expansion, which would change the region's long-term economic role. Dr. Kasarda noted, however, that the airport area would also become increasingly attractive to non-complementary economic activities ranging from residences to consumer retail. Other commercial and industrial developments not closely tied to aviation would also likely be drawn to the airport and its environs. To guard against developments that could encroach on future needed airport expansion and prevent long term options for aviation-related economic activities that would contribute to Piedmont Triad International Airport's emerging role as the Central Business District (CBD) of the Piedmont Triad Aerotropolis, Dr. Kasarda recommended the Piedmont Triad Airport Authority implement zoning, tax abatements, and a land acquisition program in the near future.

PORTLAND INTERNATIONAL AIRPORT – PORTLAND, OR
AIRPORT OVERVIEW

Portland International Airport is the primary commercial service airport serving northwest Oregon and southwest Washington. Owned and operated by the Port of Portland, the airport is located approximately five miles northeast of downtown Portland, OR and three miles southeast of downtown Vancouver, WA. Primary access to the airport is provided via Interstate 205. The airport occupies an approximate 3,400-acre site.

Portland International Airport experiences approximately 223,000 annual aircraft operations (AIC-NA, 2010). The airport has two parallel runways, both of which are equipped with instrument landing systems, and one crosswind runway. Runway 10R/28L is the primary runway, measuring 11,000 feet long by 150 feet wide. The airport is also supported by a passenger terminal building consisting of five concourses.

Portland International Airport is classified as a medium hub airport in the NPIAS, offering non-stop service to 50 domestic and five international destinations. The airport is currently served by fifteen passenger airlines which handled nearly 13.2 million passengers in 2010. Alaska and Horizon Airlines use the airport as a regional hub. In addition, more than 190,000 metric tons of air cargo was handled at the airport in 2010 by the passenger airlines as well as nine cargo airlines (AIC-NA, 2010).

AIRPORT MASTER PLAN

The Port of Portland completed a master plan for Portland International Airport in 2000. This master plan, completed during a period of strong economic growth, anticipated continued expansion of the airport and major airport improvements in the future, including a potential third runway and new passenger terminal. After the completion of this master plan, there were significant changes in the aviation industry caused by events such as the terrorist attacks in 2001, economic recession, and rising fuel costs. There were also changes in the planning and development process for the airport.

Historically, the Port of Portland operated Portland International Airport under a Conditional Use Master Plan approved by the City of Portland. This approval had to be renewed every eight to ten years.

The approval process involved the City's review of all airport development projects to ensure mitigation of development affects. This process was burdensome for the Port of Portland, required technical expertise regarding airport growth that the City of Portland lacked, and limited the public's involvement in airport development decisions. As a result, a collaborative planning process referred to as "Airport Futures" was created beginning in 2001. Airport Futures involved the Port of Portland, City of Portland, and Portland, OR-Vancouver, WA community with the objective of creating a long-range master plan for Portland International Airport and a City land use plan governing the airport and its environs. Sustainability and livability were important principles incorporated throughout the process.

Jacobs Consultancy was selected to complete the Master Plan Update for Portland International Airport, which was initiated in 2007 and finalized in 2010. Because of the changes in the aviation industry since the 2000 master plan, the 2010 Master Plan Update provided flexibility to accommodate previously anticipated activity levels, but recognized that a third parallel runway and new passenger terminal would not be needed by the study's planning horizon year of 2035.

Air Cargo Methodology

Existing Conditions

In 2007, ten all-cargo and integrated express cargo airlines handled approximately 280,000 U.S. tons of cargo at Portland International Airport. It is important to note that the 2010 Master Plan Update defined cargo as both freight and mail. The primary passenger airlines that carried belly cargo included Alaska Airlines, American Airlines, Continental Airlines, Delta Air Lines, Lufthansa German Airlines, Northwest Airlines, Southwest Airlines, United Airlines, and US Airways. Total land area dedicated to air cargo facilities was approximately 200 acres, total building space was approximately 763,500 ft^2, and total ramp space was approximately 2.3 million ft^2. Cargo facilities used by the passenger airlines for belly cargo were located north of Runway 10R/28L in the North Cargo Complex, Northeast Cargo Complex (vacant in 2007), and Southeast Cargo Complex. The all-cargo and integrated cargo carriers used facilities located south of Runway 10R/28L in the AirTrans Cargo Center. Additional cargo facilities were located south of Runway 10R/28L at the airport's Southwest Ramp.

Air Cargo Volume Forecasts

Unconstrained air cargo volume forecasts were prepared using 2006 as the base year and 2035 as the planning horizon year. The forecast process involved extensive collaboration between Jacobs Consultancy, Port of Portland, City of Portland, Metro (the Portland-Vancouver region's Metropolitan Planning Organization), the public, a peer reviewer, and other key stakeholders. The key steps of the process were as follows:

- Review of the 2000 Master Plan forecasts and historical air cargo activity from 1976 to 2006.
- Collection and analysis of data related to the key issues and trends affecting future aviation demand at Portland International Airport. Key issues and trends were grouped into five main categories that included a) aviation industry, b) regional/economic, c) global, d) technology, and e) external event.
- Development of an econometric model that related cargo tonnage to total personal income for the Portland-Vancouver region.
- Development of probabilistic forecasts of air cargo tonnage. Probabilistic forecasting is an innovative tool in the development of aviation forecasts, because it allows for the assessment of the uncertainty associated with future aviation demand.

Low (10th percentile), medium (50th percentile), and high growth (90th percentile) forecast scenarios were prepared. The Master Plan Update was based on the medium growth scenario, but because probabilistic forecasting was used, the Master Plan Update had the flexibility to accommodate the high growth or low growth forecasts. Total air cargo tonnage for the medium growth scenario was projected to increase from 285,000 U.S. tons in 2006 to 732,000 U.S. tons in 2035 at an average annual growth rate of 3.3%.

Aircraft Operations Forecasts

The forecasts of air cargo tonnage were used to generate probabilistic all-cargo airline aircraft operations forecasts. The methodology involved estimating the percentages of future cargo tonnage to be carried by air carrier and commuter aircraft. In 2006, air carrier and commuter aircraft transported approximately 94% and six percent of the cargo carried by the all-cargo carriers at Portland International Airport, respectively. Jacobs Consultancy increased the air carrier percentage slightly over the planning period.

Once the shares between aircraft sizes were estimated, total air carrier cargo operations were calculated by dividing the cargo tonnage to be carried by all-cargo carriers by estimates of cargo tons per departure for both air carrier and commuter aircraft. In 2006, this ratio was approximately 27.7 U.S. tons per departure for air carrier aircraft and approximately 0.58 U.S. tons per departure for commuter aircraft. Both ratios were increased over the planning period, because the all-cargo carrier fleet was expected to include larger aircraft and regional feeder cargo carriers were anticipated to transport greater air cargo volumes to other airports in the region with developing markets.

Similar to the air cargo volume forecasts, low, medium, and high growth forecast scenarios were prepared for the all-cargo airline aircraft operations. All-cargo airline aircraft operations for the medium growth scenario were forecast to increase from 33,184 operations in 2006 to 52,320 operations in 2035 at an average annual growth rate of 1.6%.

Facility Requirements

Facility requirements that would accommodate projected air cargo tonnage through 2035 were developed for three facility components:

- *Processing and Warehouse Space* – The Master Plan Update did not include the USPS's facility (114,500 ft^2) in the facility requirements planning process since the facility was used for ground sorting purposes only. Therefore, in 2007, there was a total of 649,039 ft^2 of cargo building and office space at Portland International Airport. The consultant used a square feet per annual ton ratio. The total building utilization rate (square feet per annual ton of cargo processed) at the airport was 2.32 in 2007, which was lower than the utilization rates at many North American airports with cargo facilities. It was noted that the low building utilization rate at the airport may partly be attributable to inefficient space allocation. To develop a utilization rate for the Master Plan Update, Jacobs Consultancy considered the utilization rates assumed for the 2000 Master Plan, the existing utilization rate at the airport, and the planned utilization rates at selected peer airports, including Ontario International Airport, Tampa International Airport, Seattle-Tacoma International Airport, and San Diego International Airport. Based on this analysis, the Master Plan Update used the ratio of 1.50 ft^2 per annual ton of cargo to forecast future cargo building requirements for belly cargo and all-cargo facilities. In 2035, it was estimated that approximately 1.1 million square feet of cargo building space would be required at the airport, a deficiency of approximately 449,000 ft^2. The deficiency was due to requirements for the all-cargo facilities.
- *Ramp Area* – There were approximately 256,000 yd^2 of cargo ramp area at Portland International Airport in 2007. Jacobs Consultancy noted that its experience indicated a planning factor of 7.5

ft^2 of ramp per annual ton of cargo handled by the all-cargo carriers was appropriate to estimate ramp area requirements for the all-cargo category. For belly cargo, which requires a minimal amount of ramp area, a planning factor of 1.0 ft^2 of ramp space per ton of air cargo was used. By applying these planning factors, it was estimated that 565,000 yd^2 of ramp space would be required by 2035. This represented a deficiency of 309,000 yd^2, the majority of which related to all-cargo operations.

- *Landside Areas* – The landside area requirements were approximately equal to the cargo building requirements. In 2035, approximately 1.1 million square feet of landside area would be required.

In all, the total land requirement to accommodate the air cargo tonnage forecast for 2035 was estimated at 167 acres. A total of 206 acres were available for cargo operations in 2007. As such, the airport had existing land to accommodate the forecast demand.

Master Plan Recommendations

Following a thorough alternatives analysis, the Master Plan Update recommended strategies for accommodating future air cargo demand. The airport's existing facilities for belly cargo provided approximately 236,000 ft^2 of cargo building space, which exceeded the 2035 requirements of 93,000 ft^2. It was expected, however, that some of these facilities would be demolished in the future to accommodate other development. The Master Plan Update recommended several strategies to deal with this eventuality, including cargo-specific follow-on studies and consolidation of belly cargo facilities in the Southeast Cargo Complex.

For all-cargo facilities, it was concluded that the AirTrans Cargo Center, which as of 2007 was used for all-cargo processing, was well-designed with excellent airside and landside access. The Master Plan Update recommended that the AirTrans Cargo Center should remain the airport's primary all-cargo processing area. The recommended strategies for future all-cargo facility development, which would be necessary at every planning activity level (PAL) during the planning period, included utilization of available land near the AirTrans Cargo Center in the near-term and utilization of land in the airport's Southwest Quadrant in the long-term (2022–2035).

SAN ANTONIO INTERNATIONAL AIRPORT – SAN ANTONIO, TX

AIRPORT OVERVIEW

San Antonio International Airport is the primary commercial service airport serving the San Antonio metropolitan area, which is comprised of Atascosa, Bandera, Bexar, Comal, Guadalupe, Kendall, Medina, and Wilson counties. Owned and operated by the City of San Antonio, the airport is located approximately seven miles north of downtown San Antonio. Primary access to the airport is provided via Loop 410 and SH-281. The airport occupies an approximate 2,600-acre site.

San Antonio International Airport experiences approximately 177,000 annual aircraft operations (AIC-NA, 2010). The airport has two air carrier runways, both of which are equipped with instrument landing systems, and one general aviation runway. Runway 12R/30L is the primary runway, measuring 8,502 feet long by 150 feet wide. The airport is also supported by two passenger terminal buildings. Construction of the new Terminal B was completed in 2010 as part of the Airport Expansion Program initiated following the airport's 1998 Master Plan.

San Antonio International Airport is classified as a medium hub airport in the NPIAS, offering non-stop service to 28 destinations in the United States and two in Mexico. The airport's nine mainline airlines and 11 regional affiliates handled over 8.0 million passengers in 2010 (AIC-NA, 2010). In addition, nearly 124,000 metric tons of air cargo was transported at the airport in 2010.

AIRPORT MASTER PLAN

The Airport Expansion Program initiated as part of San Antonio International Airport's 1998 Master Plan included several major projects in addition to the construction of Terminal B. A long-term parking garage was constructed in 1999, the U.S. 281 North Connector providing direct elevated access from SH-281 North to the terminal and parking facilities at the airport was opened in 2001, and a Terminal Renovation and Concession Redevelopment Plan was completed in 2003. In 2009, the City of San Antonio began planning for the airport's next phase of growth by initiating the San Antonio International Airport Vision 2050 Master Plan. The Vision 2050 Master Plan evaluated the airport's future role in the south-central Texas region and examined how the airport could serve as an economic engine, enhance trade relationships, facilitate an integrated multi-modal transportation system, and protect the region's natural, historical, and cultural resources. The City of San Antonio hired the consulting firm AECOM to complete the Master Plan, which was approved by San Antonio City Council in March 2011.

Air Cargo Methodology

Existing Conditions

In 2008, San Antonio International Airport was served by several all-cargo and integrated cargo operators and forwarders. The integrated cargo airlines included DHL, FedEx Express, and UPS. The airport's all-cargo airlines included Ameriflight, Astar Air Cargo, and Martinaire. CEVA Logistics (Eagle Global Logistics) served as a ground cargo handler. The airport transported approximately 142,000 metric tons of cargo in 2008, with FedEx Express and UPS handling approximately 87% of this freight volume. Approximately 76% of the total air cargo was freight and the remaining 24% was mail.

The airport's cargo facilities were located in two areas on the airport: the West Cargo Complex and the East Cargo Complex. These facilities are described below:

- *West Cargo Complex* – The West Cargo Complex accommodated the West Air Cargo Terminal and USPS. The West Air Cargo Terminal, owned by the City of San Antonio and partially leased to cargo handlers and airlines, consisted of an 82,560 ft^2 warehouse. Lessees included Cargo Airport Services, Southwest Airlines Air Cargo, Delta Air Lines, Mexicana de Aviacion, and American Airlines. The USPS occupied a 52,000 ft^2 customer service and shipping facility. The West Cargo Complex consisted of a total of 9.5 acres of ground lease; 164,729 ft^2 of building space; 8,430 yd^2 of ramp area (used only for ground support vehicle loading and storage); and 172,880 ft^2 of landside area.
- *East Cargo Complex* – CEVA Logistics, DHL, FedEx Express, and UPS were located in the East Cargo Complex. The air cargo facilities in this area consisted of a total of 34.5 acres of ground lease; 104,000 ft^2 of building space; 117,340 yd^2 of ramp area; and 339,230 ft^2 of landside area.

In all, the airport's air cargo facilities consisted of 44 acres of ground lease; 268,729 ft^2 of building space; 125,770 yd^2 of ramp area; and 512,110 ft^2 of landside area.

Air Cargo Volume Forecasts

AECOM prepared unconstrained air cargo volume forecasts for San Antonio International Airport for the period 2008 through 2050. Several key factors that would affect aviation demand at the airport were considered when developing the forecasts, including population, economic and political conditions, financial health of the airline industry, airline service and routes, airline competition and airfares, airline consolidation and alliances, availability and price of aviation fuel, aviation safety and security concerns, and capacity of the national air traffic control system. In addition, independent national forecasts prepared by the FAA, Airbus, and Boeing were reviewed to serve as a benchmark for the San

Antonio International Airport forecasts. The following summarizes the key points noted in the Master Plan regarding the long-term growth outlook for the air cargo market at the airport:

- Future growth in Gross Domestic Product (GDP) would largely determine future cargo tonnage at the airport.
- Anticipated growth in U.S. domestic air cargo tonnage would be lower than in international markets such as intra-Asia or domestic China, since the U.S. air cargo market is considered a comparatively mature market.
- There would be slower growth in the rapid express shipment market than was experienced in the 1980s and 1990s, since this market was now considered to be mature.
- High fuel and operating costs would continue to cause air cargo tonnage to shift from aircraft to truck transport.
- Belly cargo tonnage would continue to decline and some belly cargo tonnage would likely shift to all-cargo carriers due to the 9/11 Commission Act of 2007, which required that 100% of cargo transported on passenger aircraft to be screened by August 2010.
- Air freight was projected to grow at a higher average annual rate than mail due to the increased use of e-mail and other forms of electronic communication.

Baseline, low-growth, and high-growth forecast scenarios were developed in the Master Plan. The baseline, low-growth, and high-growth forecast scenarios assumed different timeframes for the recovery of the national economy following the economic downturn that began in 2007. In the baseline forecast, which was selected as the forecast for the Master Plan, air cargo tonnage was projected to increase from 141,399 metric tons (33,624 metric tons of mail and 107,774 metric tons of freight) in 2008 to 553,472 metric tons (42,521 metric tons of mail and 510,951 metric tons of freight) in 2050 at an average annual growth rate of 3.3%.

Aircraft Operations Forecasts

Similar to the air cargo volume forecasts, baseline, high-growth, and low-growth forecasts were developed for all-cargo aircraft operations. The Master Plan provided limited information regarding the methodology used to prepare the forecasts. In the baseline forecast, which was selected as the forecast for the Master Plan, all-cargo aircraft operations were forecast to increase from 7,206 operations in 2008 to 20,000 operations in 2050 at an average annual growth rate of 2.5%.

Facility Requirements

Air cargo facility requirements were developed for the following three functional areas on the airport:

- *Processing and Warehouse Space* – In 2008, San Antonio International Airport's warehouse utilization rate for belly cargo was 0.37 tons of air cargo per square foot of warehouse space. For the all-cargo and integrated carriers, the warehouse utilization rate was 1.26 tons of air cargo per square foot of warehouse space. AECOM considered industry best practices related to cargo planning when developing the warehouse space requirements. According to AECOM, the generally accepted cargo facility use ratio for an automated facility is 0.75 tons per square foot, and for a highly automated cargo facility, the ratio is 1.5 tons per square foot. AECOM assumed that the warehouse utilization rate for belly cargo at the airport would increase from 0.5 tons per square foot in 2010 to 0.75 tons per square foot by 2030 as a result of the increased use of mechanization technology. AECOM also assumed a warehouse utilization rate of 1.2 tons per square foot for all-cargo facilities. Based on these assumptions, the airport's existing belly cargo warehouse space of 29,525 ft^2 would be able to accommodate the demand forecast for 2030, as only 22,460 ft^2 would be required by 2030. For all-cargo activity, the airport's existing 104,000 ft^2 of warehouse space would need to be expanded by 111,000 ft^2 by 2030 to accommodate projected demand.

- *Ramp Area* – San Antonio International Airport provided approximately 119,000 yd^2 of cargo ramp area in 2008. To develop future ramp area requirements, AECOM used a planning factor of 7.5 ft^2 of ramp per forecast ton of all-cargo airline freight. AECOM noted that this factor accounted for aircraft parking and staging areas for freight and support vehicles, but did not include ramp space required for aircraft circulation. To arrive at total cargo ramp requirements, the parking ramp space requirements were multiplied by a factor of 1.4 to account for service roads and taxi lanes meeting ADG-V separation standards. Based on a planning factor of 1.0 ft^2 of ramp per forecast ton of belly cargo, the airport's existing belly cargo ramp area of 2,210 yd^2 would be able to accommodate the demand forecast for 2030, as only 1,870 yd^2 would be required by 2030. For all-cargo activity, the airport's existing 117,340 yd^2 of ramp area would need to be expanded by 184,000 yd^2 by 2030 to accommodate projected demand.
- *Landside Areas* – The cargo landside areas at San Antonio International Airport included parking areas for visitors and employees, truck circulation, loading docks, and landscaping. The cargo landside area approximately equals the required cargo building area. The Master Plan determined that the airport's existing 375,290 ft^2 of landside area would not require expansion to accommodate forecast demand, as only 237,470 ft^2 would be required by 2030.

In all, AECOM determined that the airport's existing belly cargo facilities had sufficient capacity to accommodate forecast demand through 2030. However, approximately 20 additional acres of land would be needed to support all-cargo operations in 2030.

Master Plan Recommendations

Expansion of the airport's all-cargo facilities to accommodate the demand forecast for 2030 would have to occur either north or south of the airport's existing cargo facilities due to the locations of environmentally sensitive sites and previously planned development. An analysis of four cargo development alternatives was conducted in the Master Plan to arrive at a preferred alternative. The recommended cargo development alternative consisted of a 50-acre development north of the existing cargo facilities with up to 13 aircraft positions. The site would require significant earthwork, but avoided environmental issues associated with two of the other alternatives. AECOM also noted that a minor FAR Part 77 tail penetration would occur at one of the wide-body aircraft parking positions located within this site.

SUMMARY

Chapter 3 represents a review of 12 recent airport master plans published between 2005 and 2011 and focused on each plan's air cargo volume forecasts, air cargo aircraft operations forecasts, facility requirements, and recommendations. The next chapter focuses on the air cargo industry trends and operations.

CHAPTER 4: TASK 1—OVERVIEW OF AIR CARGO INDUSTRY AND TRENDS

CHAPTER OVERVIEW

Through collection and detailed analysis of the necessary data, an overview of the state of the air cargo industry was developed to classify its components and identify trends seen in recent years. The overview focused on four components: air cargo carrier activity at airports, air cargo facility development and funding at airports, air cargo industry trends, and air cargo personnel and culture. For air cargo carrier activity, the different types of cargo airlines, aircraft, airports, facilities, and buildings found throughout the air cargo industry were identified to provide insight into the functionality of the industry's components. The air cargo facility development and funding overview demonstrates the means by which air facilities are established on airports and the handling systems that operate within them. Air cargo industry trends at the major air cargo airports are organized according to size, principal functions, and geography in order to explore the relationships that provide the basis for later analyses. Lastly, the overview of air cargo personnel and culture summarizes the wide array of key personnel found within the airport community and air cargo industry as well as their roles. This task provides the necessary understanding for developing guidelines for long term air cargo facility planning and development at airports.

INTRODUCTION

This report provides an overview of air cargo carrier activity at airports, characterizes airport air cargo facilities commonly used by these carriers, as well as presents funding and finance strategies for these facilities. This report also provides an in-depth review of air cargo traffic trends at airports in North America. This report is broken into four segments:

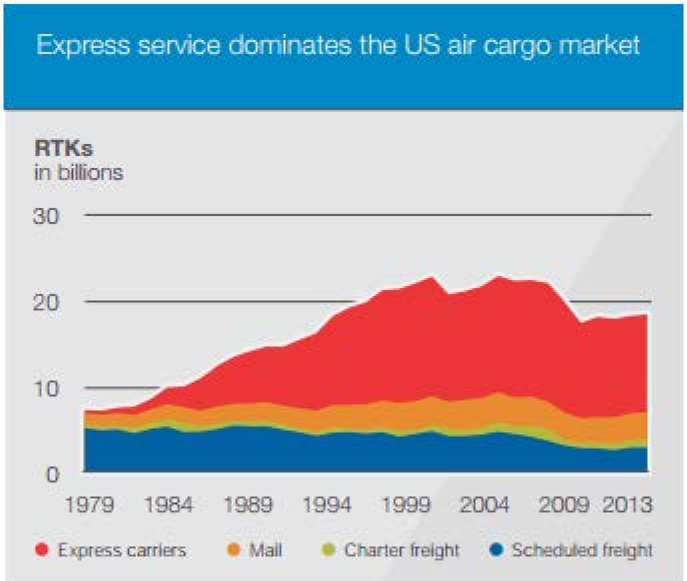
- Air cargo carrier activity at airports
- Air cargo facility finance and funding
- Air cargo industry trends
- The operators and culture within the air cargo industry

OVERVIEW OF AIR CARGO CARRIER ACTIVITY AT AIRPORTS

Cargo Airline Types

Air cargo is transported on passenger aircraft, as well as freighters or cargo-only aircraft as described below. Figure 4-1 provides historic perspective on annual cargo volumes in Revenue Tons Kilometers for express traffic, mail, chartered freight and scheduled freight. As illustrated by the graph the express has grown since the early 1980s to dominate the entirety of the U.S. air cargo traffic.

Figure 4-1 Historic Air Cargo Market Share (SOURCE: Boeing 2014-2015 World Air Cargo Forecast.)



Passenger Airlines – Air cargo services provided by passenger airlines vary in scope and size from airline to airline, based on the type of aircraft operating within their fleet. A regional airline, with a fleet of turboprop and regional jets, cannot accommodate bulky cargo due to limited cargo capacity in baggage compartments. Airlines operating wide-body passenger aircraft often have containerized lower decks and are capable of handling larger shipments. Passenger airlines generally provide airport-to-airport service, with freight and mail carried as "belly" cargo. Freight on passenger airlines is dropped off at a warehouse at the origination airport by the shipper (or freight forwarder); the freight is then picked up at the destination airport by the customer (or freight forwarder) after arriving on the passenger airline.

All-Cargo Carriers – All-cargo carriers operate airport-to-airport air cargo and freight services for their customers but do not offer passenger service. All-cargo carriers include Polar Air Cargo, Atlas Air, and Kalitta Air Cargo, to name a few. Prior to its merger with Delta Air Lines, Northwest Airlines was one of the world's largest cargo airlines, operating a dedicated fleet of 14 B747F freighters. It was the only U.S. combination carrier (passenger and cargo service) to operate dedicated 747 freighters. As a result of the Northwest/Delta merger, the dedicated Northwest cargo freighters have been phased out and Delta is once again a belly-only cargo carrier (Air Cargo News, 2010). Internationally, Japan Airlines, Korean Air, China Airlines, Singapore Airlines, Lufthansa, and Emirates are also passenger airlines with their own fleet of dedicated freighter aircraft. Other all-cargo carriers without passenger service include: Jade Air Cargo, Atlas Air, Polar Air Cargo and Evergreen. All-cargo carriers offer scheduled service to major markets throughout the world using wide-body and/or containerized cargo aircraft.

Combination Aircraft Carriers – Carriers that have both passenger and freighter aircraft in their fleet are considered "combination carriers." These carriers include Cathay Pacific, Emirates, and Lufthansa. For example, Lufthansa operates freighter versions of the MD-11F and the B777F. Combination Aircraft Carriers are often confused with a type of aircraft which carries both passengers and cargo on the main deck of the aircraft. "Combi" aircraft in commercial aviation is an aircraft that can be used to carry either passengers, as an airliner, or cargo as a freighter, and may have a bulkhead partition in the aircraft cabin to allow both uses at once. These combi aircraft typically feature an oversized cargo door, as well as tracks on the cabin floor to allow the seats to be added or removed quickly. These aircraft were marketed early on by Boeing as “Convertible” or “QC” (Quick Change), since they facilitated a rapid conversion between roles. Alaska Airlines operates B737-400 combi aircraft to primarily service airports in Alaska. At the international level, Asiana and KLM continue to operate B747-400 combi aircraft which allow ULD containers and pallets to be loaded onto the rear portion of the main deck through a large cargo door while passengers travel in the forward portion of the main deck.

Heavy Lift Cargo Freighters – Heavy lift cargo freighters are operated by charter cargo airlines such as Volga-Dnepr Airlines and Antonov Airlines, providing specialized heavy lift operations with its fleet of Antonov An-124 and An-225 aircraft, respectively. Limited numbers of these aircraft exist, as they are some of the largest aircraft in the world; therefore, operations are typically highly specialized charters. These carriers transport goods and equipment for businesses and governments. This type of cargo operation is commonly referred to as project cargo.

Integrated Express (FedEx Express, UPS, and DHL) – Integrated express operators move the customer’s goods door-to-door, providing shipment collection, transport via air/truck, and delivery. Integrated express operators include FedEx Express, UPS, and DHL (DHL’s U.S. domestic pickup and delivery service was discontinued in January 2009). FedEx has several product types that utilize the FedEx brand name in some form. FedEx Express is the integrated express arm of the company, providing the “overnight service” synonymous with the brand. FedEx Freight is a trucking division which specializes in freight weighing over 150 pounds and offers fast-cycle logistics with regional next- and second-day service, including accelerated service in three days or more. Table 4-1 identifies the integrator hub airports worldwide for DHL, FedEx Express, and UPS. Express companies provide next-day and deferred time-definite delivery of documents and small packages (two to 70 pounds). Integrated express operators are increasingly transporting “heavy” freight, (over 70 pounds). Integrated express operators utilize a hub-and-spoke transport model, similar to passenger airlines. The air cargo hub used for package sortation and aircraft transfer is the backbone of integrated express operators. This allows for total product connection to each market in the operator’s system. Each day of operation, flights from around the world arrive at the hub, where packages are unloaded, sorted by destination market, and then loaded onto outbound aircraft. Integrators often make heavy use of automated sorting at their hub terminals in order to achieve desired turnaround times and delivery commitments.

Table 4-1 Worldwide Integrator Hub Airports.

DHL	FedEx Express	UPS
United States		
Cincinnati/Northern Kentucky	Memphis International	Louisville International
International	Indianapolis International	Philadelphia International
	Fort Worth Alliance	LA/Ontario International (CA)
	Newark Liberty International	Dallas/Fort Worth International
	Oakland International	Chicago Rockford International
	Ted Stevens Anchorage International	Columbia Metropolitan
Latin America/Caribbean		
Miami International	Miami International	Miami International

DHL	FedEx Express	UPS
Tocumen International		
Canada		
	Toronto Pearson International	John C. Munro Hamilton International
Europe/Middle East/Africa		
Leipzig/Halle	Cologne Bonn Airport	Cologne Bonn Airport
East Midlands Airport	Paris-Charles de Gaulle Airport	
Bahrain International		
Asia Pacific		
Hong Kong International	Guangzhou Baiyun International	Hong Kong International
Chennai International		Shenzen Bao'an International
		Shanghai Pudong International

SOURCE: CDM Smith.

Regional Air Cargo Carriers (Wiggins, Mountain Air, Ameriflight) – Regional air cargo carriers operate between O&D/local market stations and smaller or more remote cargo markets, typically in support of a larger integrated express cargo operator such as FedEx, UPS, or DHL. Wiggins Airways and Mountain Air Cargo are examples of contracted “feeder” airlines to both UPS and FedEx. Feeder flights often transport cargo from a smaller market and feed cargo to an awaiting cargo jet bound for the carrier’s hub. Feeder aircraft may also fly directly to a hub. Ameriflight is a regional cargo carrier not affiliated with any larger airline, providing custom and time-critical charter flights moving air freight from point-to-point.

Air Forwarders/Road Feeder Service – A freight forwarder is an intermediary that arranges the best means of transport for goods, typically by accepting small packages from shippers and consolidating them into container loads. These loads are then transferred to the non-integrated carrier or passenger airline to deliver to an agent or subsidiary at the destination airport. (FedEx, UPS, and DHL sell capacity to forwarders when space permits). Freight forwarders rely heavily on lift provided by commercial passenger carriers, road feeder service providers, as well as all-cargo carriers. Freight forwarders generally have their leading gateways near major hub airports such as Chicago O’Hare International and New York’s John F. Kennedy International. One major exception is Huntsville International, where several major forwarders have operated for many years. The largest international air freight forwarders are DHL Global Forwarding, Kuehne + Nagel, DB Schenker, and Panalpina.

Forward Air is another example of a freight forwarder, which provides scheduled surface transportation for less-than-truckload (LTL) air cargo shipments coming off aircraft that must be delivered at a specific time, but is less time-sensitive than traditional integrated express services. This is a reliable and more cost-effective alternative to air transportation. Forward Air operates its central sorting facility at Rickenbacker International Airport in Columbus, Ohio, in addition to 11 regional sort centers on or near airports.

Road feeder service (RFS) – is a service offered by a scheduled cargo operator to move goods to and from the aircraft and/or terminal by truck road service. This allows a carrier to offer services to a city to which it does not fly aircraft. These services are typically allocated an airline waybill number although no aircraft may be involved in the transport.

Specialized (guppy, medical, etc.) – Specialized air cargo providers have unique capabilities to carry freight that is oversized/bulky or freight that requires special conditions. Aircraft such as the Aero Spacelines Super Guppy, Boeing DreamLifter, and Airbus Beluga are unique in their ability to haul oversize items that are not extremely heavy, typically aircraft parts. Limited numbers of these aircraft exist, as operations are highly specialized. Quest Diagnostics, a diagnostic testing and information services firm with its own fleet of aircraft, provides transport service for laboratory test samples, medical materials, and equipment. Many of the aircraft are small jets customized to carry time and temperature sensitive items.

Aircraft Types

There are three major kinds of aircraft that serve as air freighters: wide-body jets, narrow-body jets, and narrow-body turboprop aircraft which commonly function as feeder aircraft. A significant number of freighters in service today are converted passenger aircraft that have reached the end of their service life as passenger carriers as illustrated in Figure 4-2 to Figure 4-5. Other freighters, particularly wide-body freighters, are manufactured as such by Boeing and Airbus. The converted freighters tend to be significantly older, less fuel efficient, and, given their age, are more susceptible to maintenance problems than their passenger carrier counterparts and recently manufactured freighters. Freighters used on international North Atlantic and Pacific routes are usually wide-body freighter aircraft with payloads ranging from 80,000 to 234,000 pounds. The exception is the DC-8 which is a narrow-body transoceanic aircraft.

As stated previously, international air cargo travels in the baggage compartment, or lower deck, of passenger aircraft; this cargo is also referred to as “belly cargo.” The wide-body aircraft that typically serve these routes offer substantial freight capacity. This capacity is increasing with the next generation of aircraft. For example, the Airbus A330/340 passenger aircraft have much greater cargo capacity per available seat than their predecessors, offering space for up to 32 lower deck containers. Pure freighters utilize both main deck (normally the passenger area) and lower deck positions (“baggage compartments”) for freight carriage.

The sharp increase in jet fuel costs has forced air cargo carriers to reconsider the practice of flying older, less fuel-efficient aircraft. In 2005, Boeing had a record year for orders of freighter aircraft. The rising fuel costs made airlines realize they needed to “re-fleet” to modern, more fuel-efficient aircraft. For example, Nippon Cargo Airlines (NCA) currently operates eight B747-400 aircraft. In 2005, they ordered 10 B747-800, which is marketed as the most efficient cargo plane in the world with greater fuel efficiency and space for four additional main deck containers.

Figure 4-2 Wide Body Freighter Sample, Boeing 777-200. (SOURCE: Boeing Aircraft Characteristics for Airport Planning.)

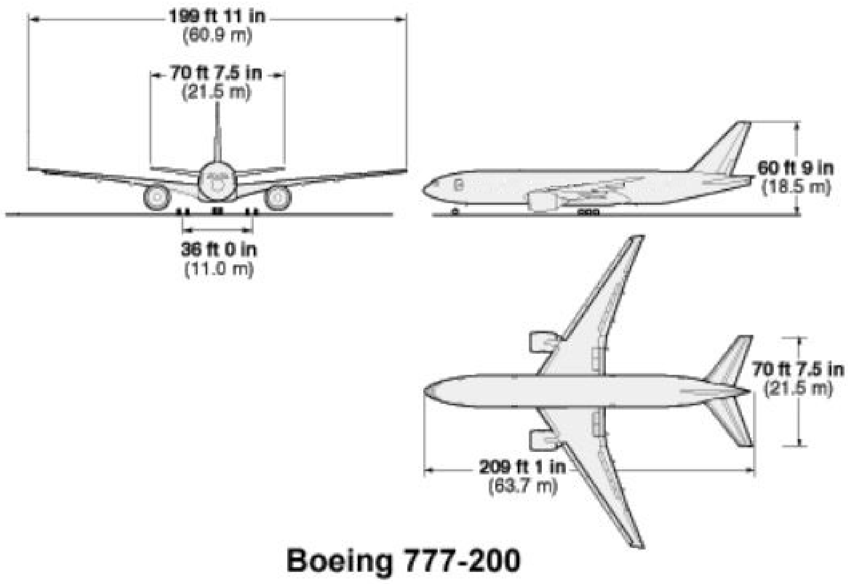


Figure 4-3 Wide Body Freighter Sample, Airbus A300-600. (SOURCE: Airbus 3-view Aircraft Drawings.)

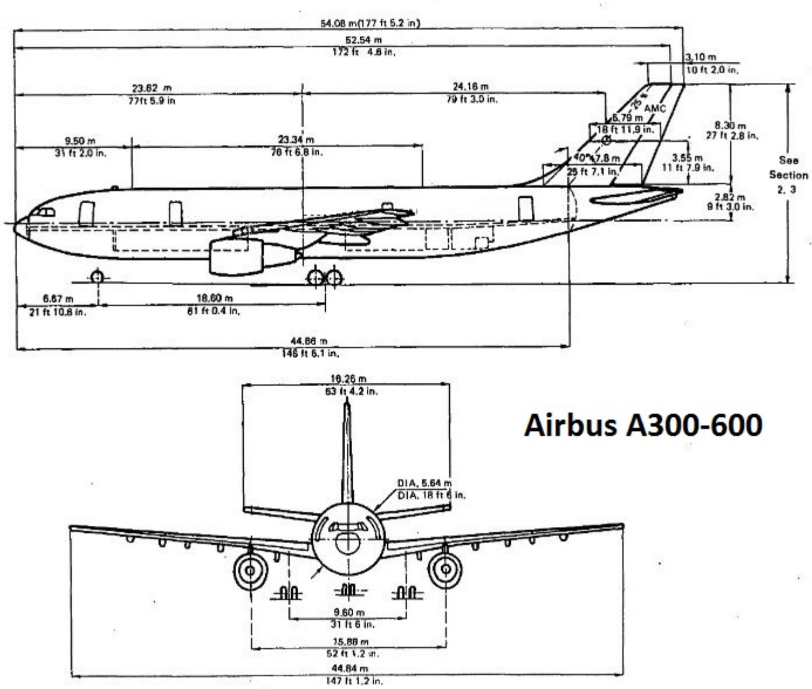


Figure 4-4 Narrow Body Freighter Sample, Boeing 757. (SOURCE: Boeing Aircraft Characteristics for Airport Planning.)

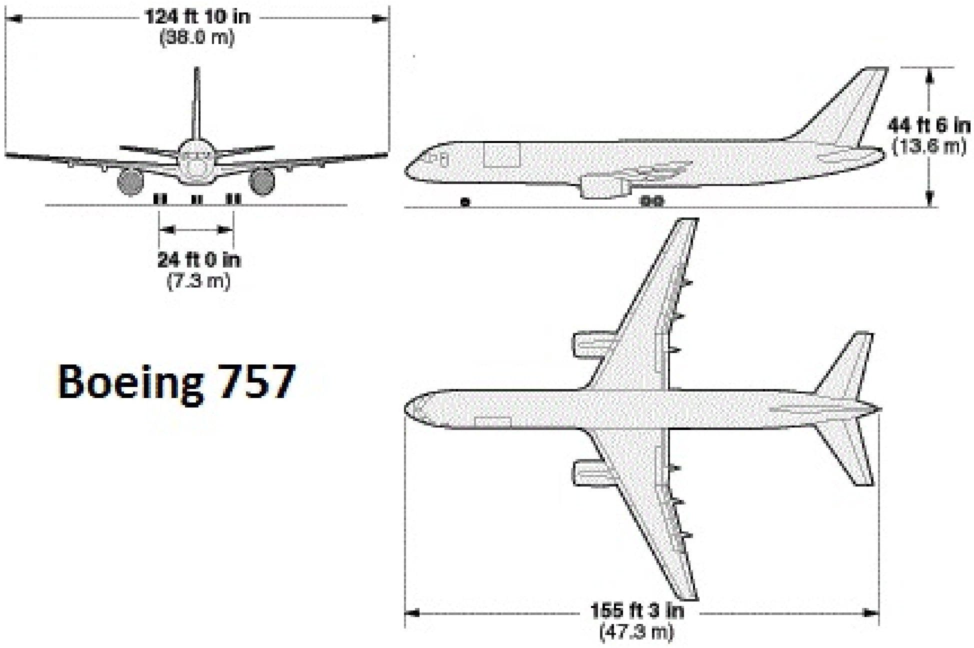
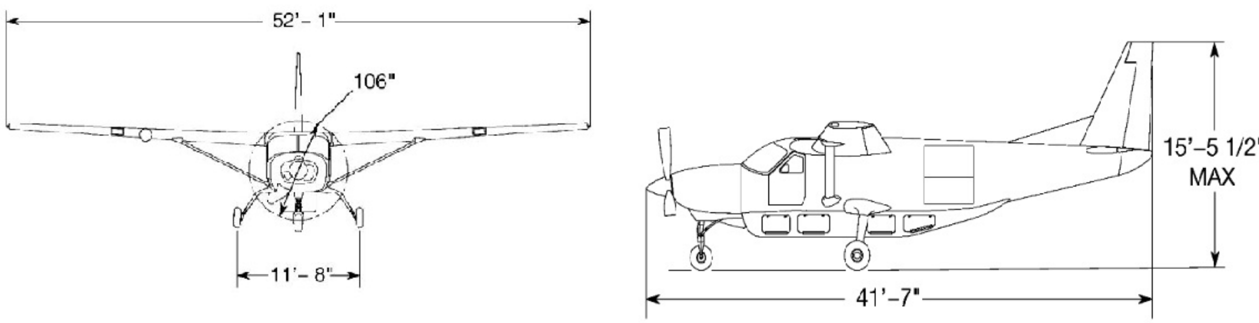


Figure 4-5 Regional Air Cargo Feeder Aircraft Sample, Cessna Caravan 208B. (SOURCE: Cessna Information Manual.)



Cessna Caravan 208B

Perhaps one the most unique attributes of wide-body and narrow-body freighter aircraft is their ability to accommodate unit load devices (ULDs), which include containers and pallets. These aircraft have large doors and rollers fastened to the deck of the aircraft. These aircraft allow containers and pallets laden with freight and mail to be rolled on and off aircraft with relative ease as illustrated in Figure 4-6.

Unit Load Device (ULD) – is either a container or pallet that is loaded onto the aircraft and unloaded at its destination. Types of ULDs are illustrated in Figure 4-6. A container is an aluminum box that is shaped to fit the contoured sides of an aircraft. A pallet is a solid wood, metal, or plastic transport structure on which shipments are stacked and wrapped in plastic and netting. The advantages of a pallet over a container are lower weight, cheaper to own/repair, easier to handle, and empty stacking. The main advantages of containers are that they are fully enclosed, protecting their contents from the elements and theft. A disadvantage of both is that they are easy to damage. ULDs loads can be assembled at the airport or arrive pre-assembled.

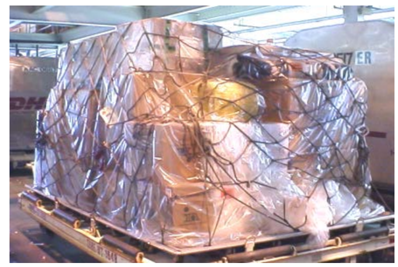
Wide-body aircraft have rollers on both the main and lower decks while narrow-body aircraft have rollers strictly on the main deck. The lower decks of these aircraft are bulk loaded or loaded manually. Specialized ground handling equipment lifts containers and pallets to the main deck. Containers and pallets are typically loaded and unloaded in a warehouse which may or may not be located on an airport. Containerizing or palletizing air cargo allows for quick and efficient loading and unloading of aircraft as well as trucks. In addition, some warehouses have "roller deck" flooring which allows for movement of pallets and containers without the need for forklifts, dollies or tugs.

Figure 4-6 Types of Unit Load Devices (ULD). (SOURCE: CDM Smith.)

Upper Deck Container

Lower Deck Container

Upper Deck Pallet



Approximately 50% of international air cargo travels in the baggage compartment, or lower deck, of passenger aircraft; this cargo is also referred to as "belly cargo." The wide-body aircraft that typically serve these routes offer substantial freight capacity in lower deck containers.

Narrow-body jet aircraft are typically used for average short haul domestic routes, while feeder aircraft serve relatively smaller market needs. Narrow-body aircraft payloads range from 18,000 pounds to 95,000 pounds. Feeder aircraft payloads can range from 2,000 to 10,000 pounds. Upper decks on narrow-body aircraft accommodate containers, while the lower deck is bulk loaded in a process in which individual pieces of freight are placed directly into the aircraft without the benefit of containers. Feeder aircraft are typically bulk loaded only.

Introduction of New Freighters

Uncertain and rising fuel prices enhance the value of newer airplanes that offer higher operating efficiency and hasten the retirement of freighters by airlines. Many aging first-generation wide-body freighters, such as 747-200Fs and older A310Fs, A300Fs, and DC-10Fs, were retired as a result of the recent market decline. This trend of fleet modernization is expected to continue. In addition and according to the Boeing World Air Cargo Forecast 2011, regulatory pressures on noise, emissions, and aircraft aging drive carriers to accelerate evaluation of their fleet requirements.

The introduction of new wide-body freighter aircraft such as the Boeing 747-8F, Boeing 777F, and Airbus A330F has altered the landscape by shortening the economic life of older, less fuel-efficient freighters. The Boeing 747-8F is 18.3 feet longer than the 747-400F and provides approximately 16% more cargo volume while returning 17% better fuel economy (Morrell, 2011). The 747-8F entered service in the late 2011 with Cargolux Airlines. The Boeing 777F and Airbus A330F are new large and medium-sized twin-engine freighter aircraft, respectively, that have significant advantages in fuel efficiency, range, and emissions over their three and four engine predecessors.

Aircraft Range

Improvements in aircraft manufacturing and design have led to aircraft that can fly longer distances and still transport a significant amount of payload. As a result, the number of international gateways has increased, and established gateways may now be bypassed. Prior to the advent of extended-range aircraft, most international gateways in North America were located along east and west coast cities. Aircraft with extended ranges, both passenger and cargo air carriers, are now able to fly from cities located in the interior United States such as Memphis, Indianapolis, and Denver to overseas destinations. For example, in 1997 FedEx Express began operating a nonstop flight from Memphis (MEM) to Osaka (KIX), over 6,800 miles in stage-length.

Table 4-2 identifies typical freighter aircraft and their maximum ranges which are used for air cargo transport. It should be noted that heavier payloads decrease the range of an aircraft, as do weather conditions, but most cargo aircraft never reach more than 80% load factor due to cubic capacity being reached before weight capacity. It is noteworthy to point out that while many of today's newer freighter aircraft have the range to operate nonstop between Asian markets and airports in the contiguous States, a majority of air carriers choose to carry less fuel in exchange for additional payload, requiring that they stop in Anchorage to refuel, thereby increasing aircraft efficiency. UPS and FedEx also have sizeable sort operations at Anchorage making their operations increasingly more reliant on that location.

Table 4-2 Typical Freighter Aircraft Ranges.

Freighter Aircraft Type	Aircraft Body Type	Max Range Nautical Miles	Max Range Statute Miles
B747-200F	Wide	4,000	4,603
B747-400F	Wide	7,670	8,724
B777 Freighter	Wide	8,865	8,864
AB330 Freighter	Wide	6,400	6,398
MD-11F	Wide	4,450	5,122
757-200 Freighter	Narrow	2,737	3,150
767-300 Freighter	Wide	2,841	3,270
767-200ER	Wide	5,734	6,600
DC8-72F	Narrow	4,000	4,603
AB340	Wide	6,950	8,000
AB380	Wide	5,647	6,500

SOURCE: Manufacturer's Aircraft Technical Specifications.

Airport Types

Airport types are derived from observations of primary cargo activity taking place at airports and are specific to this report. These descriptors do not equate to legislative or FAA classifications of airports.

International Gateways – The gateway functions as a consolidation, distribution, and processing point for international air cargo. To a certain extent, an international air cargo gateway is similar to a hub airport in that the gateway airport is not reliant on the surrounding market area to generate sufficient cargo to justify air cargo-related operations. As with the air cargo hub, much of the cargo moving through a gateway airport does not originate and is not destined for the gateway airport's surrounding market area. Airports in the U.S. that are considered international gateway airports include: Miami International (MIA), John F. Kennedy International (JFK), Los Angeles International (LAX), and Chicago O'Hare International (ORD). Evolving gateway airports include Hartsfield-Jackson Atlanta International (ATL), Dallas/Fort Worth International (DFW), and George Bush Intercontinental (IAH). Detroit Metropolitan Wayne County (DTW) functions as a gateway to a lesser degree since the airport accommodates Delta international flights to Asia and Europe.

National Cargo Hubs – The hub is the backbone of an integrated express carrier since it provides connections to each market in the integrator's system. Each day of operation, flights from around the world arrive at the hub. Once at the hub, packages are unloaded, sorted to the appropriate destination market, and then loaded back onto the appropriate outbound aircraft. The majority of enplaned air cargo traffic at a hub/sort facility is generated from the aircraft-to-sort-to-aircraft process. The cargo traffic originating or destined for the local market is often a small percentage of the airport's total enplaned cargo traffic. In effect, the hub imports and exports demand for air cargo facilities and operations at the host airport. Major hub airports in the U.S. include Memphis International (MEM), where FedEx Express operates its "super" hub, Louisville International (SDF), where UPS has its global hub, and Cincinnati/Northern Kentucky International (CVG), where DHL operates its U.S. hub. The market area of an airport's cargo hub is typically located within a three hour driving radius of the airport. Typically there are no cargo flights from the hub to airports within this radius since trucking is a less expensive alternative.

Regional Hubs – Regional hubs serve the region in which they are located by performing the cargo sorting and distribution functions of that specific carrier's primary hub. UPS has regional hubs at DFW, Chicago Rockford International (RFD), Columbia Metropolitan (CAE), as well as Ontario International (ONT), thereby allowing cargo within those markets to bypass UPS' main hub in Louisville. UPS operates deferred parcel hubs at Des Moines International (DSM) and Spokane International (GEG). Similarly, FedEx Express has regional hubs at Oakland International (OAK), Fort Worth Alliance (AFW), Piedmont Triad International (GSO), and Indianapolis International (IND), enabling cargo within those markets to bypass FedEx's main hub in MEM.

O&D/Local Market Stations – The criteria for a local market station, or direct air cargo service (origin and destination [O&D] service to an airport's surrounding market area) generally coincides with population centers where there is a concentration of industry, commerce, and transportation infrastructure. Often referred to as a "node" within a cargo carrier's network, the local market station is the simplest and most common type of air cargo facility. These airports represent the "spokes" in a hub-and-spoke air carrier network. For airport-to-airport service providers, the local market station represents the origin or destination point for the cargo they are transporting.

The sole function of a direct air cargo service facility is to collect from customer's outbound air cargo and distribute customer's inbound air cargo to the airport's surrounding market area. In order to make direct air cargo service economically feasible, the airport's surrounding market area, or "catchment area," must generate enough inbound and outbound cargo and revenue to offset the carrier's aircraft operational costs. If the carrier cannot meet the aircraft operational costs, the cargo is trucked to the hub or another local market station where it is loaded onto an aircraft.

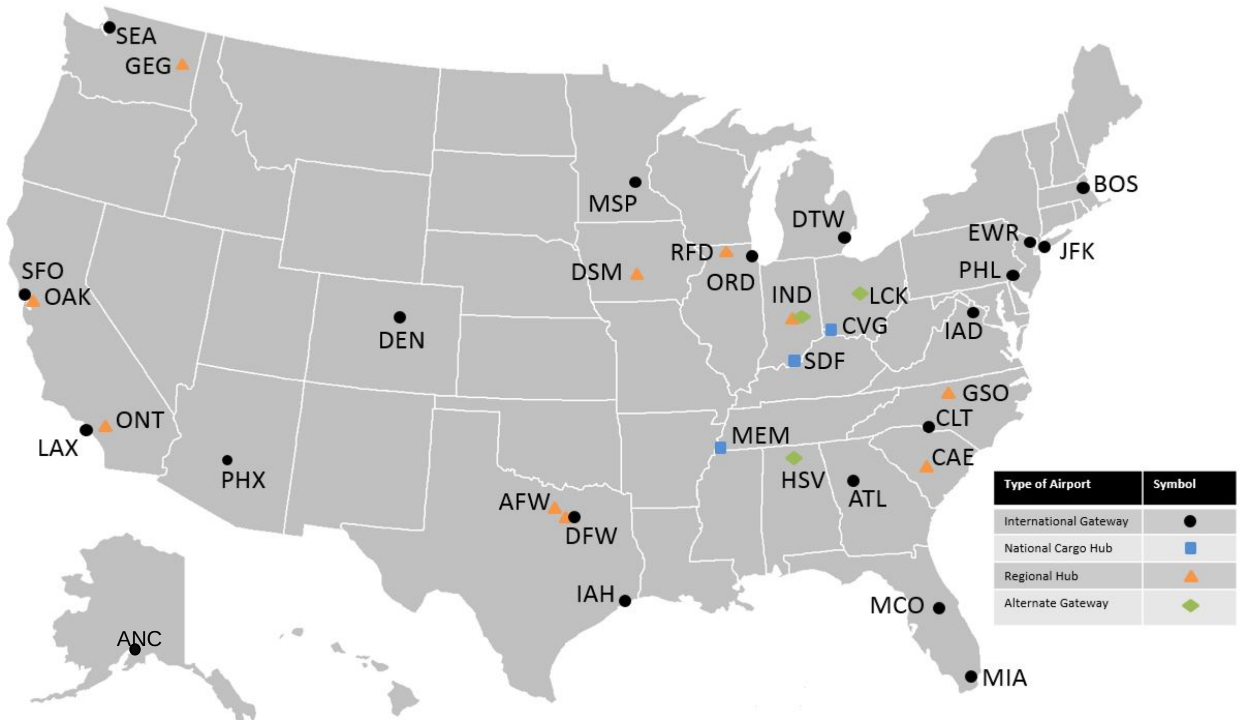
Cargo Airports – Cargo airports are dedicated to the movement of air cargo and offer the advantage of uncongested airspace relative to airports with passenger airline service. Just as the lack of passenger service is an advantage to cargo carriers operating at these airports, it is also a disadvantage for forwarders and other customers as belly space for cargo parcels is unavailable. As a result, few examples of strictly cargo airports exist.

Rickenbacker International Airport (LCK) serves as an intermodal cargo port for FedEx Express, Mountain Air Cargo (a contracted feeder airline for FedEx), UPS, several freight forwarders, as well as CSX and Norfolk Southern rail providers. Rickenbacker is not solely a cargo airport, as it is home to the Ohio Air National Guard's 121st Air Refueling Wing and has been served by passenger airlines, off and on, in recent years. Montreal-Mirabel International (YMX) is another example of a primarily "cargo airport." With the exception of general aviation users, medical evacuation operators, and a Bombardier Aerospace facility, the only major users of the airport are cargo airlines. YMX is the primary cargo gateway for the Montreal market as cargo airlines are not permitted to operate out of Montreal-Pierre Elliott Trudeau International (YUL). Prior to closure in 2009, Airborne Airpark (ILN), located in Wilmington, Ohio, was the only true "cargo airport" as it was owned and operated by DHL (and formerly Airborne Express) solely as its primary integrated express hub.

Intercontinental Hubs – An intercontinental hub connects two or three continents by air cargo and passenger aircraft and can be located in relatively remote parts of the world, away from dense populations. These airports offer cargo hub capability as well as aircraft service centers for aircraft needing to refuel and change crews. Only a few airports in the world are considered true intercontinental hubs and include Ted Stevens Anchorage International (ANC), Dubai International (DXB), and Singapore Changi (SIN). As of January 2004, a new initiative was approved in the U.S. to expand air cargo transfer rights at ANC which allows the carriage of international origin or destination cargo on foreign air carrier aircraft between Alaska and other points in the US in the course of continuing international transportation. According to the airport's website, these expanded air cargo transfer rights allow air carriers utilizing Ted Stevens Anchorage International Airport to:

- Take advantage of alliance partnerships through true interlining capabilities.
- Lower operating costs by eliminating lower revenue producing legs.
- Increase market penetration while at the same time reducing costs by eliminating beyond ANC flights.
- Higher aircraft utilization.
- Opportunities for true transfer and transload operations.
- Test market conditions without committing aircraft by utilizing code-share agreements.

Figure 4-7 Airports with Significant Role in Air Cargo Industry (SOURCE: CDM Smith)



FAA Airport Classifications

The FAA defines airports by five categories of airport activities, including commercial service, primary, cargo service, reliever, and general aviation airports, as shown below:

Commercial Service Airports are publicly owned airports that have at least 2,500 passenger boardings each calendar year and receive scheduled passenger service. Passenger boardings refer to revenue passenger boardings on an aircraft in service in air commerce whether or not in scheduled service. The definition also includes passengers who continue on an aircraft in international flight that stops at an airport in any of the 50 States for a non-traffic purpose, such as refueling or aircraft maintenance rather than passenger activity. Passenger boardings at airports that receive scheduled passenger service are also referred to as Enplanements.

Non-primary Commercial Service Airports are Commercial Service Airports that have at least 2,500 and no more than 10,000 passenger boardings each year.

Primary Airports are Commercial Service Airports that have more than 10,000 passenger boardings each year.

Cargo Service Airports are airports that, in addition to any other air transportation services that may be available, are served by aircraft providing air transportation of only cargo with a total annual landed weight of more than 100 million pounds. "Landed weight" means the weight of aircraft transporting only cargo in intrastate, interstate, and foreign air transportation. An airport may be both a commercial service and a cargo service airport.

Reliever Airports are airports designated by the FAA to relieve congestion at Commercial Service Airports and to provide improved general aviation access to the overall community. These may be publicly or privately-owned.

The remaining airports, while not specifically defined in Title 49 USC, are commonly described as **General Aviation Airports**. This airport type is the largest single group of airports in the U.S. system. The category also includes privately owned, public use airports that enplane 2500 or more passengers annually and receive scheduled airline service. The FAA's method of classification does not offer a great deal of differentiation among general aviation airports. The FAA attempted to address this shortfall in their general aviation study entitled *General Aviation Airports: A National Asset* (the 2012 Asset study). This study defined five categories of general aviation airport – National, Regional, Local, Basic, and unclassified.

Cargo Facilities and Building Types

Before and after air cargo is shipped, it needs a place to be assembled, broken down, or stored prior to customs inspection and collection. Even if cargo arrives at the airport in compatible containers, secure storage is needed before loading on the aircraft. Cargo terminals, warehouses, and other various types of buildings serve these purposes and are typically owned and operated by either the airport authority, airlines, a third party handler, or jointly by a combination of the three.

The cargo facilities at an airport are typically designed to expedite the movement of trucks, aircraft, and their shipments. At the largest international gateway airports, on-airport land is often limited and costly, so cargo terminal facilities are built to maximize volumetric capacity. At these large airports, new terminals are multi-story and multi-level. Since a significant amount of the cargo handled is loose, automated handling is crucial to efficient sorting. Bar-coded parcels and scanners are commonly used for automated handling. Another method of automated handling is radio frequency identification (RFID), where a computer chip on the ULD transmits data to radio antennae on loaders and sorters. RFID is in limited use due to issues of reliability and cost (Morrell, 2011).

The following section describes the different types of facilities used in the transport of air cargo:

Cargo Terminal (HACTL, Emirates' CMT, SATS 5) – A cargo terminal is a facility designed to move cargo containers between different transport vehicles for onward transportation. At an airport, the cargo terminal is used to move cargo between aircraft and trucks. Only a few such examples of pure cargo terminals exist in the world, including HACTL's SuperTerminal 1 at Hong Kong International Airport, Singapore's SATS Airfreight Terminal 5, and Emirates' Cargo Mega Terminal at Dubai International.

The HACTL (Hong Kong Air Cargo Terminals Limited) SuperTerminal 1 is the largest single cargo terminal in the world with over 3.5 million tons of annual cargo handling capacity. Within SuperTerminal 1 is an automated handling system where cargo containers are unloaded from the aircraft, then moved through the facility via computer-controlled conveyor belts, cranes, and hoists to specified storage positions prior to onward transportation. SuperTerminal 1 is equipped with facilities to handle many types of cargo including perishables, high-value cargo, dangerous goods, out-sized cargo, livestock, and express shipments.

Emirates' Cargo Mega Terminal (CMT) at Dubai International, which opened in 2008, has an annual capacity of 1.6 million tons of throughput. It has automated retrieval, handling and location of all cargo types from one central location using wireless technology. The CMT has an overall capacity of 2,064 general cargo ULDs, 218 perishables ULDs with multiple zones that can be maintained at different temperatures, and a 20 ULD freezer.

Warehouse – Warehouses include buildings with many different functional definitions depending on the operator's role. Activities that take place in warehouses relating to air cargo include: unloading/breakdown, buildup/loading, import/export document processing, security screening systems, tracking/tracing, inventory/control, perishables refrigeration, product inventory, delivery and receipt, scanning and processing, administration, etc.

Sort Facility – Sorting Facilities are designed to consolidate and process air cargo, routing it through the appropriate channels for further transport or local delivery. Automated sorting is used by integrators at their hub terminals in order to achieve their desired turnaround times and delivery commitments. These parcels typically weigh less than 70 pounds and are sorted using barcodes/scanners prior to being containerized for aircraft transport. Sorting air cargo may take place in warehouses, hub buildings, and hangars. These facilities do not necessarily need to be located on the airport.

Perishables Centers – Perishable centers are specialized facilities designed to handle goods that require refrigeration such as flowers, fruits, vegetables, seafood, and pharmaceutical products. These facilities are often refrigerated or contain large coolers capable of maintaining the desired temperature. Miami International Airport and its surrounding warehouse district are home to the largest concentration of perishables centers as it is the primary gateway between Latin America and the United States for produce and floral products. Indianapolis also has significant perishables capacity due to the presence of pharmaceutical giant Eli Lilly which ships regularly on CargoLux.

A new perishables facility at Sharjah International Airport (United Arab Emirates) was recently built to improve the quality of food goods and pharmaceuticals enroute from the UAE to the military forces in Afghanistan which previously relied on dry ice for cooling. The 36,900 ft^2 facility has castor deck flooring enabling ULDs to be pushed directly to the dispatch dock and onto the carrier. With two daily departures to Afghanistan, the facility currently handles approximately 5,000 tons of perishables each month and is capable of accommodating further capacity (Air Cargo World, 2011).

Cross Dock LTL Facility – A cross dock LTL warehouse is a facility where materials from trucks or rail cars are unloaded and directly loaded into outbound trucks or rail cars, with little or no storage in between.

Converted Hangars/Warehouse – A converted hangar/warehouse is a stand-alone building originally designed as an aircraft hangar, converted to be used as a warehouse for the storage and transfer of air cargo. DHL's converted warehouse at San Francisco International is a prime example of this type of facility. Brussels Airport is also home to a converted Sabena hangar that was used for air cargo sorting by DHL.

Hybrid Non-Conveyable – A hybrid non-conveyable building is a warehouse that is capable of moving bulky or oversize items via forklift. These items are non-conveyable in the sense that they cannot be moved by conveyor systems. Once de-planed, they enter the facility and are sorted then transferred to truck or aircraft for further transport.

Drop Station/Urban Consolidation Centers - An urban consolidation center (UCC) is a logistics facility situated relatively close to the geographic area that it serves (e.g. city center, an entire town or a shopping center), from which consolidated deliveries are carried out within that area. A range of other value-added logistics and retail services also can be provided. The idea is to reduce the quantity of partially loaded delivery vehicles entering the most congested parts of the road network, serving clients as part of a just-in-time logistics system12. Within the UCC, these partial loads, sometimes destined for competing retailers are transshipped into smaller vans for onward movement into the service area. These vans may also be used for the collection of return goods and/or waste.

UCC's can help reduce road freight traffic levels and environmental impacts and also influence the vehicle types used (e.g. promote last-mile delivery via electric, natural gas powered, or hybrid vehicles). They can also help focus logistics activity in certain suitable areas while helping to reduce the need for goods storage and logistics activities at urban premises. In the US, they have arisen in the private sector through 3rd party logistics companies specializing in and organizing supply services for particular industrial markets. In these arrangements, the 3PL assumes responsibility for supply services to multiple contract clients with similar needs. It then consolidates their orders and stages them through centralized and district distribution centers. The clients typically receive better goods supply with many fewer truck deliveries and less space devoted to inventory; public benefits normally are not part of the transaction, but in fact include reduced truck VMT and lower emissions. In the UK and elsewhere in Europe, they have been explored as a planning-driven initiative in pursuit of the public benefits. Under UK planning law, local authorities can safeguard land for particular development opportunities and UCC's fit the remit of sustainable development as they can directly help reduce vehicle impacts in urban centers.

Factors limiting the more widespread adoption of UCCs include the inherent delay introduced by an additional step in the delivery chain, reduction in the receiver's control of the supply chain, competition between their vendors, and the related fact that many urban deliveries entail sales functions on the part of the driver. The privately-driven approach sorts out these issues, but normally just for certain portions of the urban goods market. The publicly induced approach attempts to take on more of the traffic, but may not resolve the commercial issues, and planners favoring it may have to adopt various carrot-and-stick measures to encourage or enforce use. Even then, there may be productivity, business, and economic losses to weigh against public benefits.

Because of security concerns as well as logistics limitations, airports have been a successful example of imposed consolidation. In the US, Hartsfield in Atlanta is one that uses it, and in the UK, Heathrow in London is another. The Heathrow Consolidation Center (HCC) opened in 2001 and is a 54,000 sf warehouse facility operated by DHL-Exel in West Drayton, 1.5 miles outside Heathrow airport. It consolidates deliveries to the 323 retail and catering outlets, pubs and restaurants within the airport complex and was a planning requirement for the new Terminal 5 operation, with all retailers being required to use it. Every month the HCC receives approximately 200,000 cases from 3,500 suppliers and assembles and cross docks over 14,000 roll cages. This equates to around 490 vehicle journeys and 4,600 deliveries to the terminals each month, with an 82% reduction in supplier vehicle movements over the previous system before the HCC was implemented. By consolidating 700 inbound deliveries a week into 300 outbound, the center achieves significant environmental and operational benefits. In 2008, a total of 135,000 miles were saved from the consolidated deliveries on the DHL fleet, which amounted to 348,000 pounds fewer CO_2 emissions and a significant reduction in congestion.

The first non-airport public UCC in the UK was in Bristol which was set up as a trial in Bristol n May 2004. At the time, there were around 500,000 car movements every day in and out of the city center and average peak hour traffic speeds were down to 16mph making it one of the most congested cities in the UK with 23% of travelling time spent stationary in traffic. The challenge facing the Bristol system was that unlike Heathrow, it was not mandatory for suppliers to use it. The UCC is again operated by DHL-Exel through a 5,000 sf warehouse operating 6 days a week supplying consolidated deliveries via electric delivery vehicle to the Broadmead Shopping Center and the Galleries. Delivery vehicle movements have been reduced on average by over 72% for the 53 participating retailers, which equates to a reduction of over 60,000 truck miles. This is turn has contributed to an environmental improvement through reductions in CO_2 of 12.5 tons, NOx 1.9 tons and PM10 536 lbs. A retailer satisfaction survey carried out revealed that 94% would recommend the service to another retailer and more than half were saving over 20 minutes per delivery. The service also allows for returns where waste and packaging materials are collected from retailers.

Security Facilities

Civil aviation security measures include a combination of human and material resources to safeguard against acts of unlawful interference. The security systems found at an airport related to air cargo involves the securing of shipments against theft as well as the securing of shipments and aircraft against terrorist attack. Theft of baggage and cargo by employees or outsiders has been a problem in the past, but is increasingly deterred by the strategic placement of closed circuit cameras in handling areas. Since the terrorist attacks of 9/11 and the subsequent attempted attacks, significant measures have been taken to address vulnerabilities. These measures have impacted cargo handling processes in warehouses and have mandated carriers to provide equipment and space within their facilities to screen cargo.

Immediately after 9/11, initial measures focused on restricting access to the airside areas of the airport and standardizing passenger processing. In the United States, the Transportation Security Administration (TSA) is the agency responsible for enforcing the security recommendations within the 9/11 Act (*Implementing the 9/11 Commission Recommendations Act of 2007*), which includes air cargo. The 9/11 Act recommended that 100% of cargo transported on passenger aircraft be screened at a level of scrutiny matching that of passenger checked baggage within three years, and 50% within 18 months. As a result, the TSA implemented three programs to meet these targets: Narrow-body Cargo Screening, certified cargo screening program, and International Collaboration.

Narrow-body cargo screening became effective in October of 2008 and required that 100% of cargo carried on narrow-body aircraft (domestic or international) must be screened at the individual parcel level before it is netted, containerized, or shrink-wrapped. This segment represents over 95% of the flights in the U.S. and protects over 85% of passengers.

The Certified Cargo Screening Program (CCSP) enables freight forwarders to pre-screen cargo at their own facilities, limiting potential bottlenecks at the airport. CCSP shippers and forwarders must purchase the necessary scanning equipment, which can be burdensome for small companies as equipment may cost between $30,000 and $100,000. Lufthansa recently invested in large tunnel scanners that can scan entire containers at their Frankfurt, Munich, and Johannesburg facilities.

International Collaboration is the TSA's effort to harmonize activities with foreign partners to increase global air cargo security and reduce burdens on trade. In 2008, an agreement with the EU, Canada and Australia was signed which had a goal that by mid-2010 100% of all domestic and outbound U.S. cargo on passenger carriers should be screened by mid-2010. Inbound international air cargo did not meet the mid-2010 deadline, as implementation in foreign countries proved difficult. In 2008, the EU's Council and Parliament agreed upon a regulation that dictates that an air carrier should not accept cargo on any aircraft (passenger or cargo) unless it has applied security controls by itself or confirmed by a regulated agent.

Since there are generally stricter requirements for screening cargo carried on passenger flights than for cargo carried on freighters, the potential for problems on transshipments between those two types of carriers, such as the TSA requiring secondary screening, remains an obstacle. The investment in equipment and trained staff could also result in increasing concentration of cargo traffic at larger hub airports where economies of scale can be exploited.

SUBTASK 1.2: OVERVIEW OF AIR CARGO FACILITY DEVELOPMENT AND FUNDING

The "modern" era of air cargo can be said to have started in the early to mid-1990s with the advent of more dynamic, integrated and multimodal cargo facilities and systems at airports; dynamic in that the new facilities and systems were adapted to handle much larger volumes of cargo and with much more flow-through velocity and capacity. Integrated, in that for most U.S. markets air cargo would be dominated by the "integrated carriers" (FedEx, UPS, DHL, etc.). Intermodal, in that a large amount of "air cargo" now moves primarily by truck, at some point in the logistics chain, so airports must be true connector points between air and ground transport systems.

Air Cargo Facility Locations

Many of the facilities, and cargo processing systems they house, have evolved over the last 20 years. Consequently, airport cargo sites host a wide range of operations from entirely manual cargo handling to the most sophisticated automated sortation and processing equipment. All reflect the flow of various types of cargo, site space availability, and the types of systems favored by the passenger and cargo carriers and service providers operating at each location. In this section, we will examine both the air cargo sites and the systems within the cargo buildings and warehouses or on the sites related to aircraft apron and truck parking and access.

First, an examination of basic cargo flow is needed to better understand the process. Figure 4-8 illustrates the cargo flow at Austin-Bergstrom International Airport. With a few exceptions, the incoming and outgoing freight goes through the same process, flowing between the airside and the landside in both directions. The facilities and the handling systems within them are essentially "connectivity" infrastructure, in that they provide connections between aircraft and land transportation, both coming into the airport, and leaving the airport. All cargo sites, facilities, and equipment are some variation of this basic flow.

Nomenclature used within the industry to describe the location and type of air cargo facility is 'First Line, Second Line, and Third Line' facilities. Figure 4-9 illustrates First Line, Second Line, and Third Line facilities at Chicago O'Hare International Airport. This refers to where any particular facility might be located on the airport (First or Second Line), or near the airport (Third Line).

First Line – These sites can be defined as those having direct airside access. These are typically utilized by airlines, and ground handlers who require direct access to the aircraft, usually parked adjacent to the cargo building. *Second Line* – These sites may be on the airport premises, but do not offer direct airside access. These sites work well for tenants who do not have aircraft or can access the aircraft through other through-the-fence access points. *Third Line* – These sites are those surrounding many airports which may be owned by private landlords and while not directly connected with the airport, offer aviation service providers the proximity to the airport they desire.

Figure 4-8 Cargo Flow Diagram (Austin-Bergstrom International Airport). (SOURCE: Lynxs Group, Google Earth Pro.)

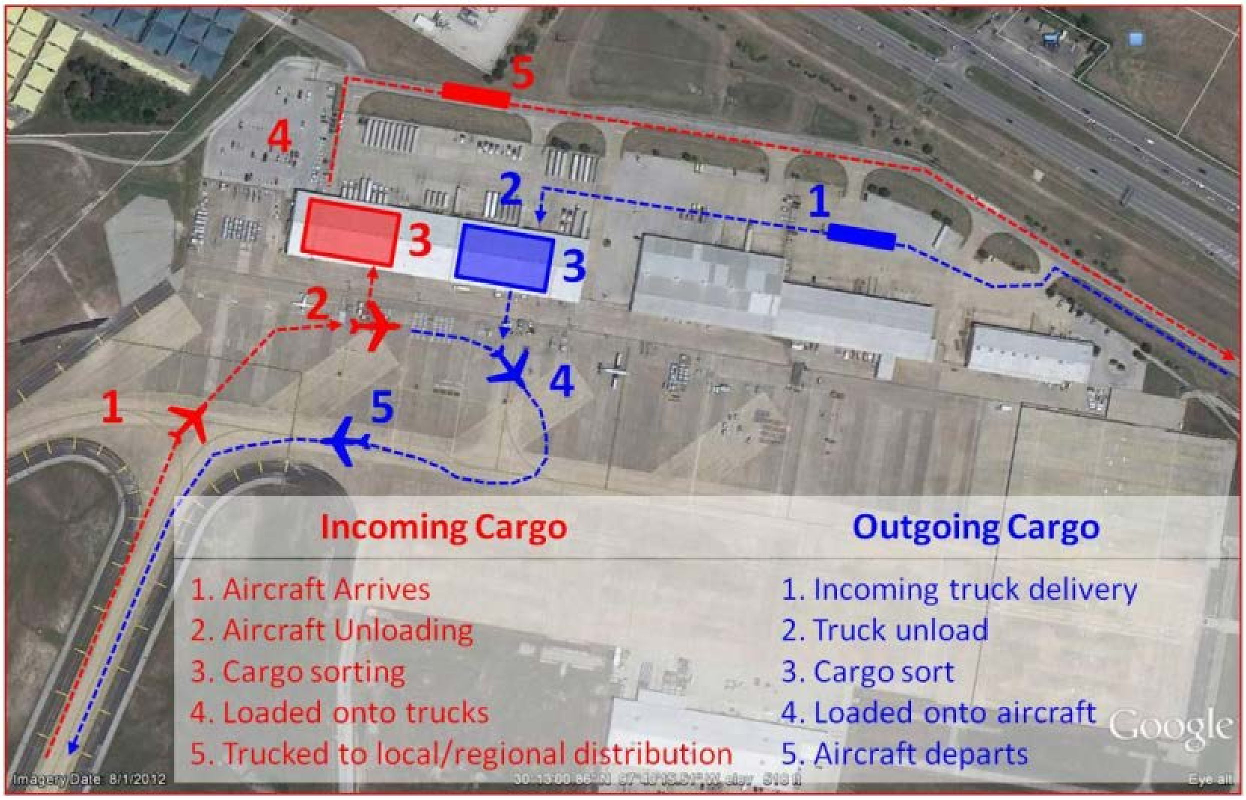
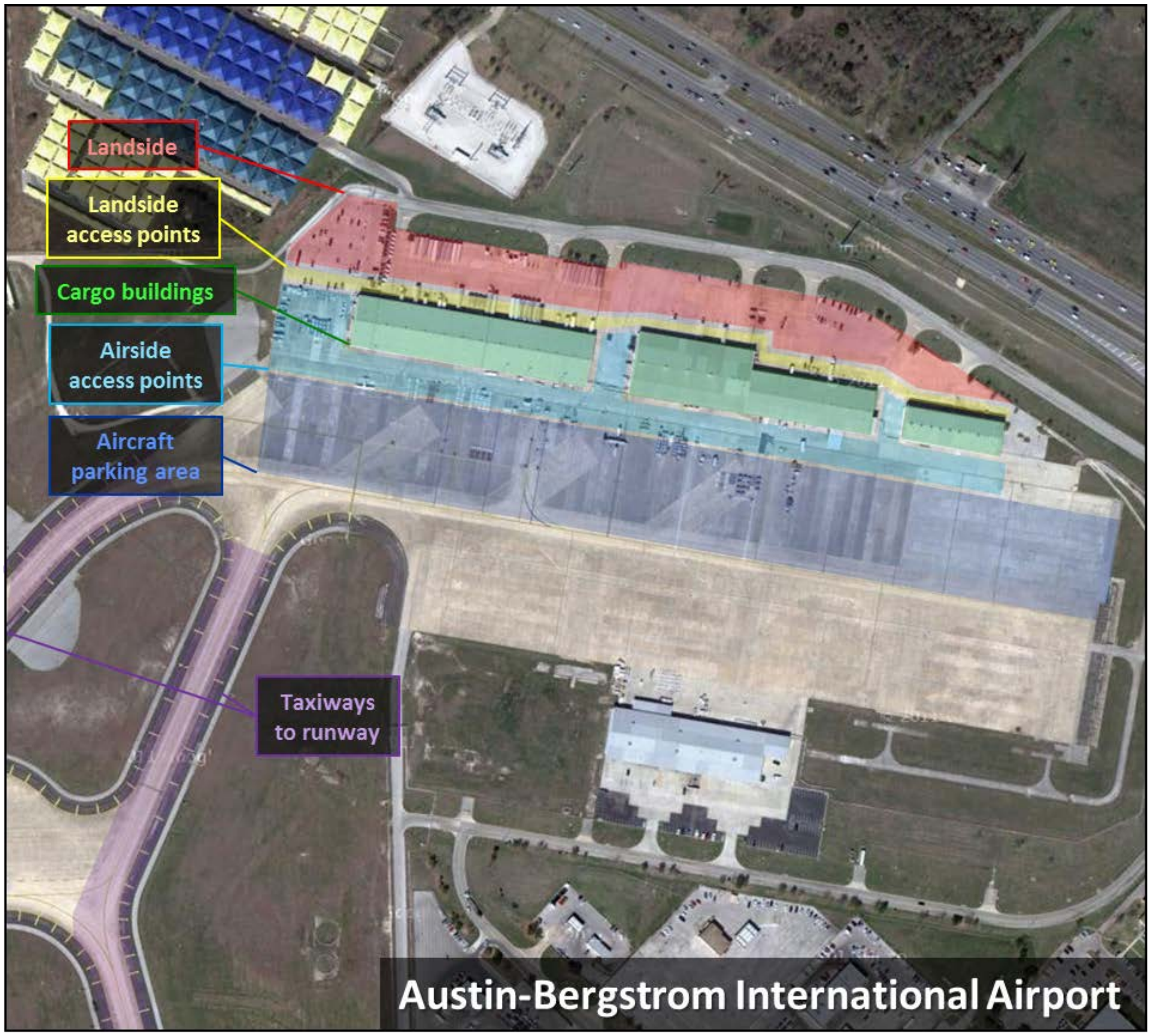


Figure 4-9 First Line, Second Line, and Third Line Air Cargo Facilities at Chicago O'Hare International Airport. (SOURCE: Lynxs Group, Google Earth Pro)

There are two basic types of First/Second Line on-airport properties: airside, meaning contiguous access to aircraft parking ramp, and non-airside, meaning on the airport grounds, but without contiguous airside access (Figure 4-10). Airside facilities are the most efficient for companies such as integrated carriers, which fly aircraft into the airport and need fast, direct handling of cargo next to their aircraft parking positions. While this space is the most expensive in many cases, carriers can often save money and time in that they can handle their cargo by simple and direct means from the aircraft to the warehouse and then to trucks and vans. Some companies have developed cargo sorting at airside facilities in recent years to improve their efficiencies. In an industry that measures performance by the minute, eliminating one handling step by having airside cargo facilities can greatly enhance system performance.

During the evolutionary process of the air cargo industry, most air cargo was originally handled at on-airport sites. However, much of this cargo activity has now migrated to non-airside sites. There is an ongoing debate of the merits of being on- or off-airport among carriers, forwarders and other ancillary services related to air cargo and logistics. Both have their relative merits, depending on the operations and services of the user. It is important to understand the dynamics of site selection and the advantages and disadvantages of the various sites which might be available for air cargo.

Figure 4-10 Airside and Landside Areas at Austin-Bergstrom International Airport. (SOURCE: Lynxs Group, Google Earth Pro)



In general, each on-airport (First Line) site includes the following components:

- Landside
- Includes truck court/staging area
- Auto parking
- Road entrances
- Landside access points
- Truck docks and doors
- Office entrances
- AOA (Air Operations Area) fence and gate entrances
- Other security access points
- Cargo building interior

- Warehouse area
- Office area
- Other specialized handling areas (hazmat, cold storage, high value, live animal, etc.)
- Customs and border protection and other official-use areas
- Cargo screening and scanning areas
- Airside access point
- At grade entrances at back of building providing equal access to and from
- Other designated and secured AOA entry areas
- Cargo handling areas
- Aircraft parking areas (often called the "apron," "ramp," "tarmac," or "hardstands")
- Taxiway connectors and taxiways to runway

All modern airside facilities must be truly intermodal, providing the main conduit between air and land transportation. Although these First Line facilities are often referred to as warehouses within the airport planning community and cargo industry; they are not truly warehouses where freight is stored for an extensive period of time, but rather rapid pass-through facilities.

Non-airside, on-airport facilities (Second Line) are alternative real estate choices for companies who do not require adjacent aircraft parking ramps, but would like immediate access to the ramps through tug and road access. These facilities are usually located adjacent to or across from airside facilities and attract air freight forwarders, ground handlers, and other logistics companies who need quick access to aircraft, but may not have their own aircraft or do not need direct aircraft ramp access. Because there is usually more building space just off the aircraft ramp, but not directly on it, these facilities typically offer less expensive lease rates than airside space but offer almost as much efficiency for those operators who do not have aircraft.

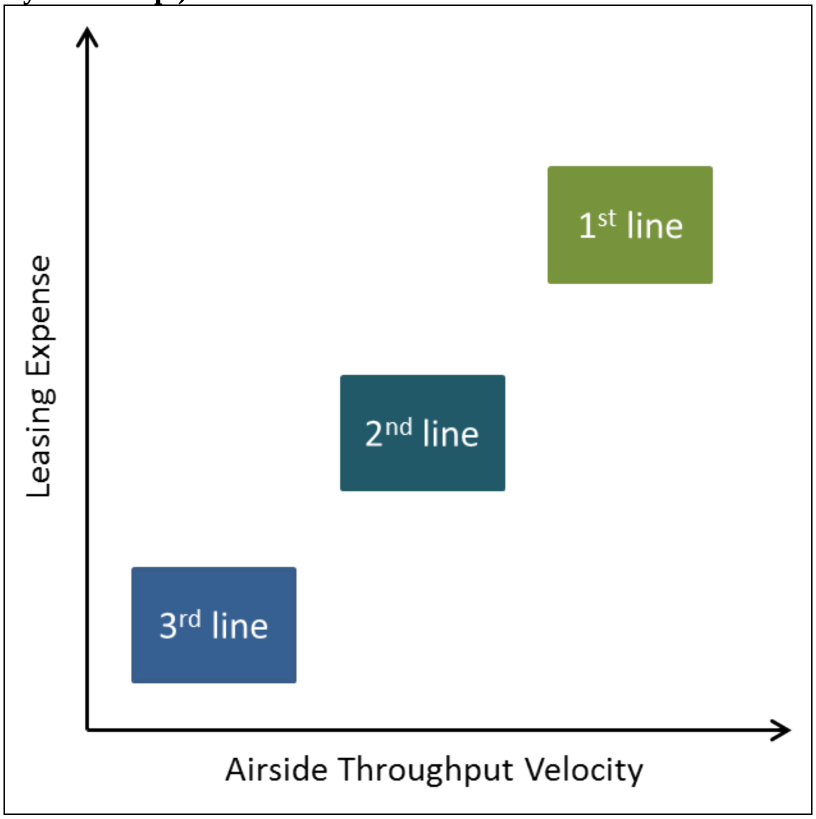
Most Second Line facilities have the following attributes:

- Usually a wider and larger building footprint than airside facilities, they begin to take on a more "warehouse" appearance,
- since they are not directly intermodal, they can sometimes cross-dock with trucks entering and docking on both sides of the building, and
- these facilities will often contain more offices and other specialized features since their greater affordability offers the user the ability to consolidate more activities on site.

Third Line facilities are those off the airport which are used in conjunction with activities on or around the airport. These facilities are typically warehouses, cross-dock loading facilities, technical support and maintenance buildings, service centers, and any number of other facilities which might be used by companies needing proximity to the airport. Clearly rents will be less expensive and these buildings are often quite a bit larger than many First and Second Line facilities. For instance if high-stacking storage, which is usually used in many types of distribution facilities, is required, these types of facilities are often built near airports, but not on airport property. These may be typical "big box" facilities, perhaps 500,000-1,000,000 sq. ft., with over 100 dock doors and would almost never be located in First or Second Line locations. Most large international gateway and hub airports are ringed with similar buildings. On the other end of the spectrum are much smaller, perhaps older buildings which might have been used for light manufacturing or storage in the past, but are now suitable for service providers, smaller logistics, and similar functions. Many airports, particularly those that are located in older, well developed urban areas, have an abundant supply of these types of facilities. These can also be considered Third Line. How far does the Third Line border extend from the airport center? Each airport catchment is different and unique to its own function, topography, and economy. But a general rule of thumb is that most buildings do not fall into this Third Line category if they are more than five miles, or ten minutes, from the airport.

Cargo finds its way through this system of First/Second/Third Line buildings by virtue of a combination of handling costs, throughput volumes, and velocity. Leasing costs are proportional to the ability to obtain throughput velocity. These relationships are illustrated in Figure 4-11.

Figure 4-11 Relationship between Leasing Expense and Airside Throughput Velocity. (SOURCE: Lynxs Group.)



Each player in the logistics chain seems to have its own optimum formula. Often these formulas are very scientific, and others might feel more "mystical," but all of the players are convinced they have the secret, and a value proposition is created by the "right mix." First Line handling costs more, and since all of the pieces in the puzzle are adjacent to each other at the airside location, one can argue that much greater throughput velocity can be achieved. There are also security and even simplicity arguments to operating airside. Second Line achieves much of this, costs a little less, but that last step, taking the cargo out the building's back door and directly on to the aircraft, is lost. How this detracts from the value proposition is a matter of interpretation, and the value proposition of First Line versus Second Line can definitely shift depending on the commodity being shipped and the operator's mission.

Sometimes there is simply no space available on the airport, so companies must choose Third Line facilities and make them work for their own needs. Irrespective, the value proposition for Third Line sites is cost – they are almost always less expensive in terms of rent, traditionally by half – but during recessionary periods, that gaps lessens as on-airport space typically discounts its leasing rates. Off-airport there is more selection, and the buildings are often bigger to accommodate a wide range of activities which might not be performed as easily on-airport. Things like automobile parking, easy access to highways and even the interaction with other parts of the logistic chain not associated with the airport come into play. Some forwarders have concentrated their sea and air facilities into single stations and are unlikely to locate on-airport when their cargo mix may be 80% ocean and 20% air at such a facility. The other side of the value proposition is less immediate access to direct airside activity as, by definition, Third Line cargo must travel by truck (or tug) over streets in order to transport to the intermodal transit point on the airport. This typically results in extra time, handling, and perhaps extra costs.

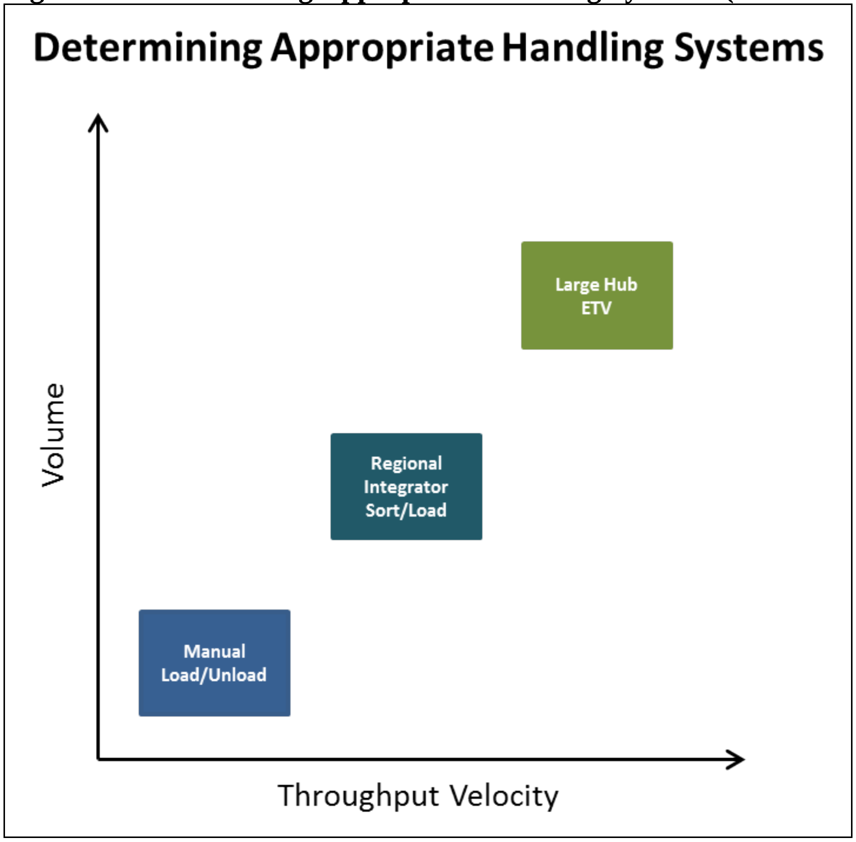
It all boils down to creating that proper balance between cost/speed/efficiency. Different companies and different commodities have different balances and the commercial ecology of any airport should provide as many choices as possible.

Air Cargo Facility Systems

Next, the various handling systems utilized at air cargo facilities will be examined. Typical air cargo handling methods range from very manual to highly automated, largely depending on the volume and speed of cargo handling required at each airport. As previously mentioned, the air cargo marketplace offers a wide variety of systems ranging from fairly basic, to a dizzying array of technical sophistication. Each has their place, form, and function. As illustrated in Figure 4-12, the type of handling system utilized is dependent to a large degree on the amount of cargo being handled and the speed at which it is being processed.

A discussion about handling systems follows the same trajectory as that of the air cargo facilities location. Most landside systems are simply dock doors to allow surface transportation (mostly trucks) to deliver the goods to the building. Not all surface cargo goes through buildings however. Many shipments are “built up” (prepared to be placed in the aircraft, either inside containers/ULDs or as break-bulk) and delivered through the airport’s airside security gates which allow trucking directly to the aircraft ramp where they are loaded onto the aircraft. But most shipments arrive through typical dock doors located along the landside of the cargo buildings. Again, some cargo has already been prepared off-site for shipment, while other cargo must be built up on site inside the cargo warehouse. Once inside the warehouse there are many activities depending on the cargo and the operator.

Figure 4-12 Determining Appropriate Handling Systems. (SOURCE: Lynxs Group.)



If a build-up is still required, some companies (mainly the integrators) sort their cargo at their airport sites (Figure 4-13). This sorting involves very sophisticated systems involving many conveyors, label readers, channeling devices and quality controls. Each package is funneled to its proper shipping container so that it can be placed on the aircraft to its destination, usually further routed through the company's hub sorting facilities.

Figure 4-13 FedEx Express Sorting System. (SOURCE: Lynxs Group.)

Heavy project cargo, or large shipments of varied cargo destined for one location and one specific project, might involve the building and labeling of crates. Perishable cargos, such as flowers, fruits, and pharmaceuticals, require very closely monitored temperature controls. High value products and bonded cargo will be kept in special areas, as will hazardous materials (hazmat). Much of this cargo is also security-screened on site. Simultaneously, paperwork is processed and other formalities transpire in adjacent offices and on the warehouse floor.

Eventually, the shipments are ready for the aircraft and if they are not already outside the building, they are taken to the aircraft for loading, usually as part of a tug and dolly train. The most sophisticated cargo facilities might have automated loading docks which will transfer cargo directly from the building to the aircraft. At the other end of the continuum are smaller packages and parcels delivered to passenger aircraft as “belly cargo” and loaded manually into the lower baggage/cargo holds of the aircraft. Airmail is carried this way into many markets around the country.

A surprising amount of cargo activity still relies upon manual labor, supplemented with rolling and loading machines such as K-loaders, forklifts and roller-beds on the floors of the warehouses and on through the airside doors (Figure 4-14). This system depends on machines supplementing worker’s guidance of the process, usually by hand. Much of the sorting, labeling, and tracking is labor intensive, using handheld devices and even handwritten manifests.

Figure 4-14 K Loader Loading On To an Aircraft. (SOURCE: Lynxs Group.)

However, as volumes and cargo flow velocities increase, so does the sophistication of the systems. Elevating Transfer Vehicles (ETVs) are automated cargo handling systems which allow for much greater efficiencies than most manual systems (Figure 4-15). When aircraft have limited time and space at any airport, particularly gateways, ETVs are the system of choice. Aircraft and their operations are expensive. They should not be stationary for long. ETVs are designed to efficiently and effectively minimize ground time, and handling mistakes.

As with First/Second/Third Line buildings, handling systems depend on the same mix of cost/speed/efficiency and will work in conjunction with the building and its location.

Figure 4-15 Elevating Transfer Vehicle (ETV) Systems. (SOURCE: Lynxs Group.)

Facilities Users

There is a rich variety of users of airport-related facilities. They are the stakeholders in the system. They can be the owners of facilities, tenants, buyers, sellers, tax and fee payers, service providers and maintainers, or even just the occasional bystanders. But all, and sometimes more, will arrive on occasion and will have different needs, wants and demands. The following is a partial list of some of these users:

- Airlines
- Integrators
- Cargo and ground handling companies
- Freight forwarders and third party logistics providers
- Air cargo-related trucking companies
- Special handlers (cool chain, high value/security)
- Security screeners
- GSE maintenance providers
- Customs, TSA, and related border protection agencies
- Other government agencies which can benefit from being on airport
- Service providers related to air cargo and airport operations
- Airport management
- Postal service providers
- Delivery service providers

Many users, such as passenger airlines, freighter airlines and integrated carriers, require their own buildings. Some airlines will share their building with their strategic partners and service providers. Other users will share multi-tenant cargo buildings and can easily adapt to most existing spaces. But the utilization of airport-related space has shifted considerably in the past few years. Twenty years ago, most cargo facility leases were signed by airlines. Now, service providers such as ground handlers are as likely to be required to take on the facilities leasing, then lump the real estate costs into the overall fees the service providers charge to the airlines.

Air Cargo Facility Finance and Funding

Airports are required by the federal government to be as self-sustaining as possible. Within this context, airports must often fund very expensive projects. Funding sources for airport projects include the airlines, capital markets, state and federal government, and the fees charged by airport itself for operations. Funding sources can vary by aviation function for a project. For example, funding options for apron areas differ from cargo warehouse options. On-airport development has many models ranging from totally publicly owned, to entirely privately owned.

Public Funding

Users of our air transportation system pay for the costs of developing and running America's National Airspace System (NAS) which include public use airports. Users include airline passengers, air cargo carriers, private pilots, corporate aircraft owners, and air cargo shippers.

For example, a portion of the U.S. air transportation infrastructure is funded by taxes on all aviation fuels. State and Federal agencies tax this fuel to provide the funds needed to make the NAS work. Passengers on commercial planes pay the fuel tax as part of their ticket price or fuel purchase. They also pay 10 percent tax levied by the federal government on all air fares. These funds are collected and then are spent on labor and equipment to operate the NAS, but are also distributed back to airports in the form of Airport Improvement Program (AIP) funds and discretionary grants.

Airport Improvement Program (AIP) - The Airport Improvement Program (AIP) is an FAA administered grant program established by the Airport and Airway Improvement Act of 1982. The FAA provides AIP grants to airport owners / operators for airport construction and safety projects. AIP grants are funded from the Airport and Airway Trust Fund, which gets its revenue from user taxes on airline passenger tickets, aviation fuel, and air cargo way bills. In addition to AIP grants, the Trust Fund pays for FAA operating costs (e.g., costs associated with operating the air traffic control system) and air traffic control system upgrades.

In federal fiscal year 2011, the FAA Reauthorization and Reform Act Of 2011 authorizes the following for the FAA's AIP: $3.1 billion for FY 2011; $3 billion for each fiscal year 2012 through 2014. AIP grants can be used for airport planning, airport development, or noise compatibility projects. Grants for airport development generally focus on projects associated with construction, improvement, and preservation of airport infrastructure, or the acquisition of land or equipment. Typical work items included under AIP development are (1) site preparation, (2) construction, alteration, or repair of runways, taxiways, aprons, and ground access roadways on airport property, (3) construction and installation of lighting, utilities, navigational aids, and aviation weather-related reporting equipment, (4) safety equipment required for certification of an airport facility, (5) security equipment required by rule or regulation, (6) snow removal equipment, (7) limited public-use terminal development at commercial service airports, (8) equipment to measure runway surface friction, (9) land acquisition, and (10) aircraft noise mitigation. AIP grants have not been made available for routine maintenance, construction of hangars, and revenue-producing public parking areas for most airports but funding for maintenance, hangars, and revenue-producing areas is available for non-primary airports and airports in the military airport program. AIP grants are either entitlement or discretionary.

Entitlement funds are awarded to airport owners / operators through a formula, based on the number of enplaning passengers and cargo tonnage. Discretionary funds are intended to provide flexibility for the FAA to meet important national airport system needs. They are used to fund capacity enhancement, noise abatement and compatibility projects, and safety and security improvements.

AIP funds are distributed as either a grant which is reimbursed as funds are expended by the airport owner / operator, or under a Letter of Intent (LOI). An LOI is a document that conveys the FAA's intention to obligate AIP funds to an airport for a specific capacity-related project over a multi-year period. Because the federal budget is only appropriated on a 1-year cycle, with an LOI, an airport can begin a project using bonds or short-term loans with the expectation of receiving AIP funds as the project progresses.

In order to obtain AIP funds, the FAA requires an airport to have a 5-year Airport Capital Improvement Program (ACIP), which details and prioritizes the airport's capital improvement needs for AIP funding. In addition to an ACIP, the project must be on an approved Airport Layout Plan (ALP), and have environmental analysis in the form of an Environmental Assessment Study or an Environmental Impact Study. Most U.S. public airports have received FAA AIP grant funding for parts of their facilities, especially the airfield. Because of this, the airports are subject to federal grant assurances/obligations which may create limitations on their ability to market and provide favorable terms to developers, notably the need for fair market value, revenue diversions and limitations on duration of leases.

State / Local Government Grants **-** Many state and local governments provide funds for airport improvements that may fund air cargo development. Each airport will need to research and coordinate with local and state government agencies to see which grants can be applied to airport cargo projects.

Debt Financing **-** Many airport sponsors such as municipal or county governments have the ability to finance capital projects by borrowing money and incurring either short-term or long- term debt. These include:

General Obligation Bonds **-** General obligation bonds, which usually require voter approval, pledge the full faith and credit of a municipal entity as security to the investor. This commitment is based on the entity's ability to levy property, sales, or income taxes. The entity gives the bondholders (investors) a first claim on its general fund, and the community pledges the ability to pass any legislation needed to increase general fund revenues to pay the debt service.

Revenue Bonds **-** Revenue bonds are issued by an airport owner / operator for projects that are anticipated to generate sufficient revenue to pay the debt service. Unlike general obligation bonds of a municipal entity, they are backed by a specific source or sources of revenue. They do not usually require voter approval. However, because the payment of debt service is limited to the revenue generated by the project, a feasibility study analyzing the projected revenues and operations of the facility being financed or improved is typically required to market and sell the bonds.

Revenue bonds may be issued tax-exempt for qualifying projects, including terminals, runways, hangars, repair shops, and land-based navigational aids. Construction of facilities such as airport hotels, retail facilities, industrial parks, and commercial office buildings on- airport, generally do not qualify for tax-exempt status. Generally, most types of airport projects can be financed using revenue bonds.

Revenue bonds may also be issued and backed by PFCs, either alone (stand-alone) or in combination with other sources of airport revenue (called double-barreled bonds).

Private Funding

Tenant or Third Party Financing - An airport may elect to use tenant or third party financing for capital projects. For example, an airport might lease a parcel of airport land to a tenant to construct a hangar or cargo facility. The airport sponsor collects ground rent for the duration of a long-term lease (usually 20 or more years). At the end of the lease, the capital improvements constructed by the tenant usually become the property of the sponsor. In the case of third party financing, the third party leases the parcel from the airport, constructs the improvements, and then rents them to one or more tenants.

Airports have explored other ways of financing airport facilities that involve varying degrees of private sector involvement in the management, capital investment decision making, financing, and pricing of airport facilities and services. Another option which is available but not widely implemented is the privatization of airports, which is being encouraged as a financing option through the FAA's Airport Privatization Pilot Program.

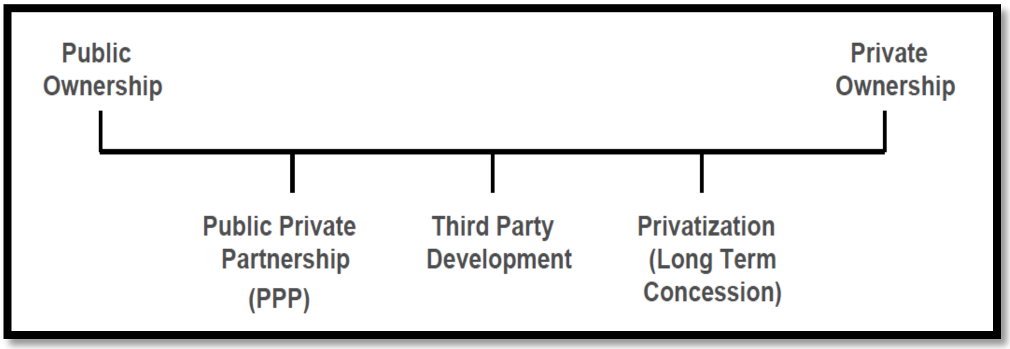
Cargo Facilities Funding Strategies

There are five broad models for this type of cargo facility development which we call the Five Ps Development Mode. They are:

- Public Ownership
- Public Private Partnership (PPP)
- 3rd Party Development
- Privatization (Long Term Concession)
- Private Ownership

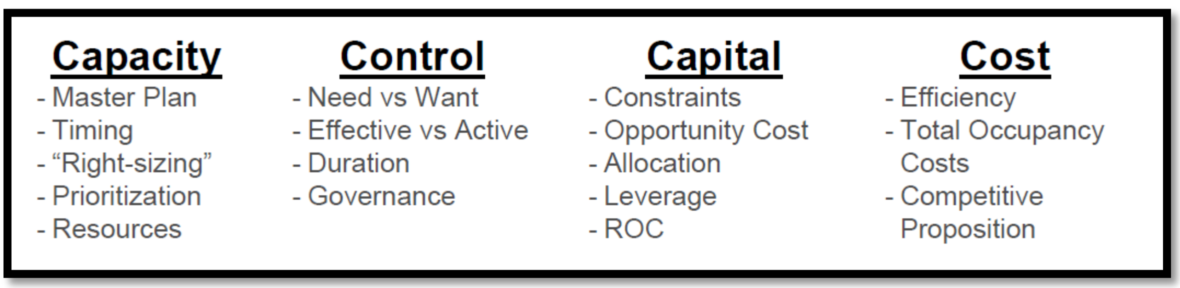
These "Ps" can be viewed as a continuum of choice ranging from complete airport sponsor control at the left axis, to handing over the entire process to private developers at the right axis as shown in Figure 4-16. What is best for each airport and stake holder in the process depends on a wide variety of data points and preferences which are identified The Four Cs (Figure 4-17).

Figure 4-16 Five Ps Development Model. (SOURCE: Lynxs Group.)



Since the decision making process usually starts at the airport, the airport's point of view must be considered. Public or private development preferences and data points can be organized using the The Four Cs methodology. The airport sponsor must determine their level of commitment in the cargo development by analyzing the facility capacity, their desired level of control, the cost associated with the project and capital/funding sources.

Figure 4-17 The Four Cs. (SOURCE: Lynxs Group.)



Capacity – How much capacity to develop, maintain and operate an air cargo facility does an organization (airport, airline, etc.) have? Is this the right time to focus on such an enterprise or is there something else in the master plan which deserves more attention? How much domain knowledge exists in-house in the field of cargo facilities development and management, or would it be better to outsource it?

Control – Everyone wants complete control when they can get it—but is this a priority at the expense of collaboration with outside parties? Control can be variable and circumstantial if structured as such. Perhaps airport governance requires airport management to have complete control of all airport development, or perhaps it allows various forms of cooperation with other parties with airport management oversight?

Capital – This issue is clearly one of the driving forces in selecting which "P" is preferred. Most decisions to not self-develop are driven either by capital constraints, or the recognition that available capital can be spent on other projects which have more return on investment than the proposed cargo projects.

Costs – Public institutions can often raise capital at far lower rates than private parties. This point, alone, guides many projects to the public domain. However, often the exact opposite is true when it comes to project pricing, particularly when the costs of expensive bidding procedures and procurement requirements are considered. The cost of risk must also be considered. Some public entities are averse to the risk of low occupancy or the potential of profitability miscalculations. Having a steady, guaranteed stream of income through partial or complete collaboration with private parties can be attractive. In other instances, the costs of having to share "the upside" may appear to exceed the benefits of partnering or turning projects over to third parties.

An overarching factor of each of the Cs is "risk." How much risk tolerance does an airport or other stakeholder have for any particular project? Public institutions may be the only players who can absorb a highly speculative venture because the risks are too great for private players and financing. Other times, any semblance of risk will drive public players out of the game because public mandates often do not accommodate project risk profiles typically associated with real estate development and investment. Each market, airport, and player mix creates a unique matrix of factors. The above allows each circumstance to be individually evaluated.

The future is about having choices and finding greater levels of efficiency. It is also about basic economics and customer service. Perhaps it is even about all levels of the supply chain finding ways, and being allowed to make a reasonably sustainable profit.

SUBTASK 1.3: OVERVIEW OF AIR CARGO INDUSTRY TRENDS

Introduction to Air Cargo Trends

In dozens of trade journals drawing from industry associations and aircraft manufacturers, overviews of the air cargo industry are easily found. Among the most commonly referenced are those accompanying institutional forecasts, such as those released annually by the International Air Transport Association (IATA) as well as biennially by Boeing. In all of these sources, the analytical perspective is primarily that of the carriers at a regional (continent or subcontinent) level. Unlike common overviews of the air cargo industry, this overview will derive its organizational form from the categories (including geographical distribution) of U.S. airports, mindful of the intended principal audience.

Industry intelligence, specifically the FAA's Terminal Area Forecasts (TAF) are predominantly used in airport planning but forecasts stratified only by such general categories as "intra-America" and "transpacific" must be carefully considered regarding applicability to individual U.S. airports. The impact of international trends has only an indirect relationship with the vast majority of U.S. commercial airports that have no international flights. Cargo (almost entirely domestic) at most airports is dominated by integrated carriers FedEx Express and UPS (United Parcel Service) with the small balance mostly carried in the bellies of passenger aircraft. Domestic volumes at these non-gateway airports are more likely to reflect local/regional economic activity but are still susceptible to network strategies by the carriers. As explored later in this section, the heavy concentration of market share among only two carriers at most U.S. airports magnifies the effect of network decisions.

The following sections organize airports according to size, principal functions and geography in order to explore air cargo industry trends that have been reflected in these airports' recent experiences, as well as to introduce causal relationships that will provide the basis for much of the later analyses as facilities planning models take shape. While the U.S. air cargo industry is heavily concentrated (in terms of annual tonnage) among only the top twenty or so airports, the consultant team is mindful that those airports dominating the U.S. air cargo industry may provide examples that are less applicable to the vast majority of U.S. airports ranking anywhere from 25th to perhaps 150th.

Composition of the Top Twenty U.S. Cargo Airports

Ranked by annual cargo tons, the top twenty U.S. airports account for over 80% of the nation's total air cargo (Table 4-3). Nine of the top twenty are national and regional hubs for integrated carriers FedEx Express (Memphis, Anchorage, Indianapolis, Newark and Oakland) and UPS (Louisville, Dallas/Fort Worth, Philadelphia and LA/Ontario) and another is the U.S. hub for DHL (Cincinnati). Thus, half of the top twenty, including those ranked first through third, owe their rankings to integrated carriers. The balance are international gateways. Almost all of these top gateways are passenger carrier hubs and a few – Dallas/Fort Worth, Philadelphia and Newark Liberty International Airport – are regional hubs for integrators, as well as domestic hubs and international gateways for passenger carriers.

Eight U.S. airports finished 2010 with more than one million tons of cargo, led by FedEx Express hub Memphis (3.9 million tons) and UPS hub Louisville (around 2.2 million tons), as well as transpacific tech stop Anchorage, which counts transit cargo left on board in its 2.6 million tons. The next four largest U.S. cargo airports are international gateways Miami (1.8 million tons), Los Angeles (1.7), Chicago (1.4) and New York JFK (1.3). The other U.S. airport with more than one million tons is FedEx's second largest U.S. hub, Indianapolis (just over 1 million tons). These eight airports alone accounted for over 16 million tons of air cargo in 2010 – about 60% of the combined total for the top 100 U.S. airports.

Detailed in later elements, the air cargo industry derives clear economies of scale with efficiencies gained in airfield improvements, allied services and technology, such as screening equipment, that must be capitalized by operations. The extent to which an airport's cargo volumes are international versus domestic, and transported on freighters versus passenger aircraft, also have ramifications on an airport's cargo facilities planning.

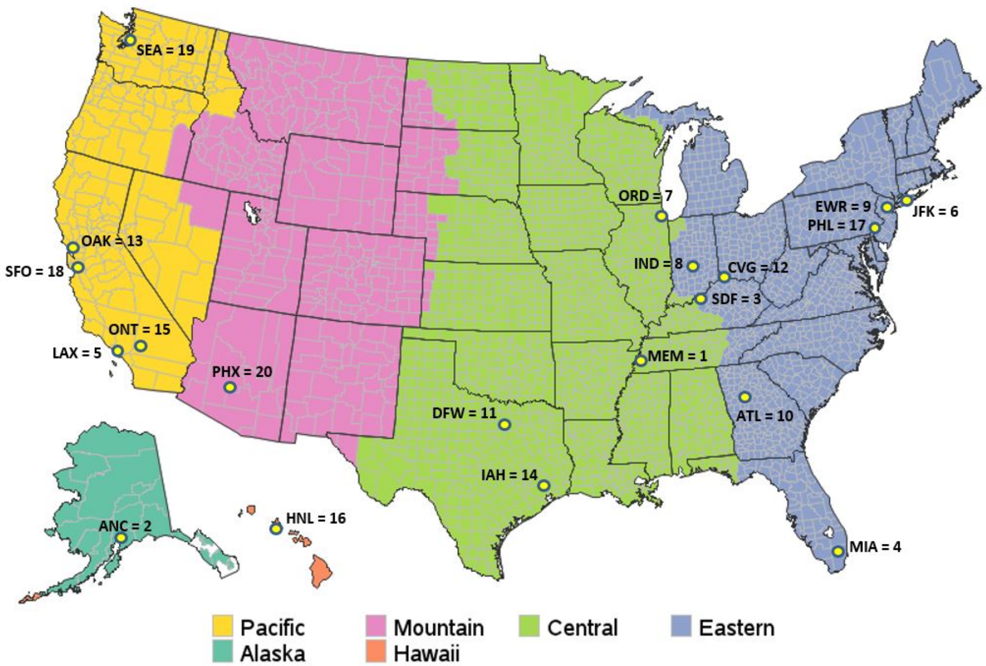
Table 4-3 Top Twenty (by 2010 Annual Cargo Tons) U.S. Cargo Airports.

Airport (code)	2010
MEMPHIS TN (MEM)	3, 916,811
ANCHORAGE AK (ANC)**	2, 646,695
LOUISVILLE KY (SDF)	2 ,166,656
MIAMI FL (MIA)	1, 835,797
LOS ANGELES CA (LAX)	1, 747,629
CHICAGO IL (ORD)	1 ,376,552
NEW YORK NY (JFK)	1, 344,126
INDIANAPOLIS IN (IND)	1, 012,589
NEWARK NJ (EWR)	855,594
ATLANTA GA (ATL)	659,129
DALLAS/FORT WORTH TX (DFW)	645,426
OAKLAND CA (OAK)	510,947
SAN FRANCISCO CA (SFO)	426,725
HOUSTON TX (IAH)	423,483

Airport (code)	2010
PHILADELPHIA PA (PHL)	419,702
CINCINNATI OH (CVG)	371,297
LA/ONTARIO CA (ONT)	355,932
WASHINGTON, DC (IAD)	332,275
SEATTLE WA (SEA)	283,425
BOSTON MA (BOS)	259,539

SOURCE: Airports Council International – North America.

Figure 4-18 2013 Top 20 Airports. (SOURCE: ACI-NA, CDM Smith.)



As reflected in Table 4-4, the period calendar year (CY) 2000 – 2010 was remarkably challenging for nearly all U.S. airports in terms of air cargo growth – with double-digit losses more common than growth. Losses during this period can be attributed to the global recession. As will be illuminated in sections on each of the individual groups below, even the appearance of relatively prosperous regions is often illusory as positive group performances were heavily anchored by only a couple of mega-airports while the remainder of the group floundered. This was the case with the Integrator Hubs and the South-Central regional groups, both of which include FedEx Express hub Memphis and UPS hub Louisville. Absent those two airports, the performance of the Integrator Hubs falls from +six percent to -23% and the South-Central average falls from +25% to -22%. Similarly, the influence of the top 4 U.S. cargo airports is so great that without them the average growth for the top 101 U.S. cargo airports falls from an already troubling -12% for the period to -30% for the airports ranking 5th through 101st. By including the 101st ranked airport, Dayton, the consultants were able to include Dayton, which is illustrative of several trends described in this narrative since it lost the former Emery Worldwide hub. The choice of an 11-year timeframe (2000-2010, inclusive) allowed the consultants to compare the last year for which complete data sets were available with the last year (2000) before 9/11 and much of the industry's contraction.

Table 4-4 Top 101 U.S. Cargo Airports: Total Annual Cargo Growth (Loss) Calendar Year (CY) 2000 – 2010. (Inclusive)

Top 101 U.S. Airports	**-12%**
Integrator Hubs (13 airports)	6%
International Gateways (13 airports)	-7%
Northeastern (15 airports)	-28%
Southeastern (19 airports)	-13%
North-Central (25 airports)	-34%
South-Central (17 airports)	25%
Northwestern (13 airports)	-41%
Southwestern (12 airports)	-20%

SOURCE: Airports Council International – North America, analysis by Webber Air Cargo

The air cargo industry experienced significant growth in the 1990s followed by declines in domestic air cargo activity and moderate growth in international air cargo activity, at key airports, from 2000 to 2010. In the 1990s, the compounded average annual growth rate (CAGR) for U.S. international air cargo was measured at 8.2% for the period. From 2000 to 2010, the CAGR for U.S. international air cargo was measured at just 2.5% which is reflective of a difficult economic period that included the 9/11 attacks, the SARS pandemic,[1] and the spike in fuel prices and the global economic recession which began in the autumn of 2008. The difference in the growth rates for the last two decades is also reflective of changes in shipper demand and a maturing air cargo market within North America.

During the 1990s, air cargo utilization by shippers was driven by several factors including an expanding global economy, the development of the internet, the dot com boom, and industry reliance on air cargo utilization for supply chain management and just-in-time business models within the manufacturing sectors. Commodities during this ten year period increased in bulk as larger computer parts and components, as well as related packaging, increased. Widely popular consumer electronic devices with limited shelf life and high seasonality also increased demand for air cargo shipments both domestically and internationally. Businesses also continued to rely on overnight document shipments as electronic transfer of signatures was not widely accepted in the finance industry.

Other drivers of air cargo growth included remarkably low fuel costs, inexpensive and abundant aircraft fleets, and capital made available to airlines at low interest rates.

By 2000, the dynamics of the air cargo industry began to change with the advent of the "factory recession" which lasted from 2000 and into 2001. Cargo tonnages dipped during this period, followed by remarkable drops in air cargo tonnages following the attacks of 9/11. The air cargo industry also experienced changes in strategy as integrated express companies moved into more efficient truck networks and resultantly purchased several national trucking firms. Consumers also became savvier in online purchases and opted for traceable deferred deliveries rather than overnight deliveries.

[1] During the SARS outbreak, the number of flights between Hong Kong and the United States fell 69%.

Commodities shipped during this period also changed as fewer documents were sent overnight as electronic transfer of legal and finance documents became more prevalent, as well as email substituting for regular mail. There were, however, increases in shipments among machinery, perishables, temperature sensitive pharmaceuticals (active product ingredients and finished product), and aerospace and automotive parts. Consumer electronic tonnages decreased in bulk and weight as products became smaller and were multi-functional (cell phones and cameras combined). Inhibitors to air cargo growth also included higher fuel costs and aircraft costs, as cargo carriers could no longer afford older less fuel-efficient aircraft. The last decade was a volatile period within the air cargo industry and its recovery will require a steady, sustained rebound.

Integrator Hubs

As referenced earlier, nine of the top twenty U.S. cargo airports (by annual tonnage) are national and regional hubs for FedEx Express (Memphis, Anchorage, Indianapolis, Newark and Oakland) and UPS (Louisville, Dallas/Fort Worth, Philadelphia and LA/Ontario) and another is the U.S. hub for DHL (Cincinnati). Because Anchorage includes transit cargo left on board, rather than requiring any local handling, some analysts exclude their totals, especially since transpacific cargo is already counted at the hub of origin/destination in the lower 48 states. For our analysis, ANC is included in discussion of integrator airports and the northwestern geographic group but ANC's tonnage is not included in the calculations of group averages. Two other FedEx Express regional hubs – Alliance Fort Worth and Greensboro – rank 30th and 40th, respectively, while UPS's regional hub at Columbia, SC ranks 52nd. UPS has another regional hub at Rockford, IL but annual cargo tonnage for this hub is unavailable. The long-time BAX Global (more recently DB Schenker) hub at Toledo ranked 21st but is expected to fall from this position since the company closed that hub in 2011. These integrator hub airports account for at least 40% of the air cargo processed at U.S. airports in CY 2010 (Table 4-5). It should be noted that Greensboro (GSO) opened in 2009.

Table 4-5 U.S. Integrator Hub Airports: Comparative Standing.

	2010 U.S. Rank	2000 U.S. Rank	Airport (code)	CY 2000 – 2010 Annual tons % change
FedEx	1	1	Memphis (MEM)	57.40%
Hubs	2	4	Anchorage (ANC)	46.70%
	8	8	Indianapolis (IND)	-13.10%
	9	9	Newark (EWR)	-21.00%
	12	14	Oakland (OAK)	-25.50%
	30	30	Fort Worth (AFW)	-47.60%
	40	57	Greensboro (GSO)	24.20%
UPS	3	6	Louisville (SDF)	42.60%
Hubs	11	10	Dallas / Fort Worth (DFW)	-28.50%
	15	15	Philadelphia (PHL)	-25.00%
	17	18	LA/Ontario (ONT)	-23.30%
	52	41	Columbia (CAE)	-55.20%
DHL	16	21	Cincinnati (CVG)	-5.00%
BAX	21	20	Toledo (TOL)	-40.30%
Emery	101	13	Dayton (DAY)	-99.00%

SOURCE: Airports Council International – North America, Analysis Webber Air Cargo.

The integrator hubs listed above experienced a group total of 6.4% growth during the period CY2000 through 2010. Individual performances were asymmetrical in that the two national hubs, Memphis (FDX) and Louisville (UPS) enjoyed 57.4% and 42.6% growth respectively, while double-digit losses were common at almost all of the FedEx Express and UPS regional hubs, except Greensboro which benefitted from having its hub begin operations during the period, albeit the FedEx Express operation at GSO was smaller than originally anticipated. The rapid growth of the major national hubs during a period when express freight declines is reflective of how these carriers reinforce their primary hubs as economies of density drops off. Typically, this reduces the advantage of creating direct routes between regional hubs and forces carriers to rely more heavily on the traditional hub-and-spoke arrangement.

Excluding Memphis and Louisville, the remaining U.S. integrator hubs experienced a collective 23% decrease in total cargo for the period, including -47.6% at Fort Worth Alliance (FedEx) and -55.2% at Columbia, SC (UPS). Even harder hit were airports hosting closed hubs, such as former Emery Worldwide hub Dayton which had been the 13th largest U.S. cargo airport in CY 2000 with 832,246 metric tons of cargo before suffering a 99% decrease to finish CY 2010 as the 101st largest cargo airport. A similar fate awaits Toledo in the aftermath of losing the former BAX Global hub. Not included in group statistics but adding to the surplus hub capacity, the former Airborne Express hub in Wilmington, OH was also closed. DHL bought Airborne Express and relocated its hub operations from Cincinnati/Northern Kentucky International Airport (CVG) to Wilmington, OH in 2005 and closed the hub in 2009 after returning back to their hub at CVG.

While the most devastating effects in surplus facilities, lost landing fees and employment, were undoubtedly imposed at airports hosting closed hubs, the ramifications rippled throughout much of the airport industry. In 2000, the top fifty commercial airports commonly had at least six all-cargo tenants. In early 2001, Emery Worldwide ceased air operations even before being acquired by UPS. Later in the decade, DHL acquired Airborne Express and closed numerous redundant facilities before ultimately abandoning the U.S. domestic market. The erosion of air operations by the former BAX Global (later DB Schenker) began around ten years ago before being completely shuttered in 2011. After the effective elimination of four major carriers, most non-gateway airports are left with only FedEx Express and UPS (or their contract carriers) as all-cargo tenants, creating unprecedented surplus cargo warehouse.

The remaining major integrators – FedEx Express and UPS – have experienced several consecutive years in which their fastest growing U.S. business segments have been deferred delivery shipments (2^{nd}, 3^{rd}-day and beyond) often served by pure surface transportation. Consequently, the carriers responsible for air cargo growth in the 1980s and 90s have focused their North American investments on trucking operations while targeting new aircraft capacity on faster growing intercontinental, intra-Asian, and, to a lesser extent, Middle Eastern routes. In the U.S., expansion by FedEx in recent years has more likely been for off-airport FedEx Ground terminals than on-airport Express terminals.

International Gateways

As noted earlier, a gateway functions as a consolidation, distribution, and processing point for international air cargo. To justify international flights, the gateway draws cargo that does not originate and is not destined for its surrounding market but rather is fed by an extended service area. In the extreme case, air cargo is routinely trucked overland by dedicated carriers between Miami and Los Angeles to take advantage of unique air connections to Latin America and Asia, respectively. The gateway is typically a hub for a U.S. legacy passenger carrier and served by one or more foreign flag carriers (often codeshare partners of the hub carrier).

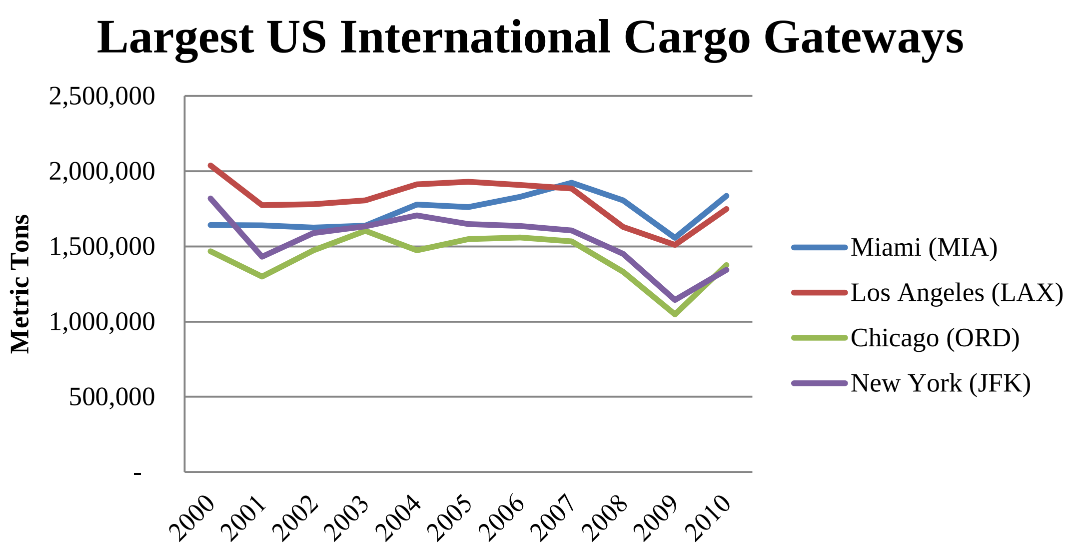
Over decades, these gateway markets developed supporting resources in terms of facilities and allied services that evolved into barriers to entry for many U.S. domestic airports seeking to expand internationally. Freight forwarders developed interdependent relationships with the network connectivity at international gateways, capitalizing on the international flights already available and by their patronage supporting network expansion. While forwarders typically exploit capacity where it is offered, their business models favor gateways offering the greatest network connectivity – the most flights to the most destinations, offered by a diversity of carriers preferably offering both passenger (for belly capacity) and freighter aircraft capacity.

International gateways still benefit from the connectivity offered by domestic hub operations, although to a lesser degree than historically. The shift from wide-body aircraft on U.S. domestic passenger flights compromised the ability to efficiently move prebuilt containers and pallets from domestic to international segments. More recently, elevated (100%) screening requirements for enplaned belly cargo introduced costs – both in screening equipment and training – which have caused carriers to truck even more cargo from secondary markets to international gateways for screening, rather than absorb those costs at the airport of origin.

While both integrator hubs and international gateways have been affected by modal shifts favoring surface transportation, air transport has also lost market share to sea transport in some traditional commodity groups. As the retail prices of electronics have declined, the value of premium air service has eroded in favor of slower, cheaper ocean transport. Until about 2007, the relatively stronger transpacific market had offset other segments' losses as shown in Figure 4-19. North America and Europe effectively substituted Asia for each other as trade partners. Miami International Airport expanded from being the traditional gateway of the Americas to also serving as Asia's gateway to Latin America. Transatlantic freighters became less common, impacting traditional gateways to Europe such as JFK. Asia is routinely projected as the air cargo industry's principal growth engine for the next twenty years, as well.

For U.S. gateways with direct service to Asia, that bodes well for the opportunity to tap into segments that will grow faster than the mature intra-North American market projected to be the slowest-growing major market. For U.S. domestic airports (by far, the majority), superior growth abroad may exacerbate the stagnation of domestic air cargo volumes, as new aircraft deliveries continue to be committed to faster-growing regions while the U.S. domestic market will be served by truck to the greatest extent possible. Alternatively, the increased fleet sizes and capabilities of aircraft have already expanded the U.S. networks of foreign carriers. Asian carriers have recently favored adding new destinations, such as Atlanta, Dallas / Fort Worth and Houston rather than simply increasing frequencies to saturated traditional gateways.

Figure 4-19 International Cargo Gateways. (Data Source: Airports Council International – North America, Analysis Webber Air Cargo)



Thirteen among the top twenty U.S. cargo airports largely fit the given description of international gateways. In addition to serving as passenger hubs and hosting other international passenger carriers, Newark and Dallas/Fort Worth (as well as Anchorage) also host regional hub operations for integrated carriers owing their rankings to both functions. As previously noted, ANC is principally a technical stop for transpacific freighters, qualifying as both an international gateway and integrator hub but in a function unlike virtually any other U.S. airport. Ranked fourth through seventh consecutively in annual cargo tonnage, Miami, JFK in New York, Los Angeles, and Chicago O'Hare have long been cornerstones of U.S. international air cargo trade. In tonnage, the smallest (JFK) of these four still accounted for more than double the annual tonnage of the next largest international gateway (excluding FedEx Express regional hub hybrid Newark), Atlanta. While Table 4-6 reveals widespread double-digit losses among the international gateways. In several cases (Atlanta, Dallas/Fort Worth, Houston and Washington Dulles) losses were made less severe by the relatively positive impact of international operations. Other international gateways – including some not ranked in the top twenty, such as Minneapolis (-42.8%), Detroit (-35.1%) and Portland (-32.6%) – suffered losses in both domestic and international volumes. These markets – as well as top twenty international gateways San Francisco (-51%) and Boston (-45.4) – may have been victims of local economic impacts as well as the consolidation of air service at larger regional competitors – LAX on the West Coast and JFK in the East.

Table 4-6 U.S. International Gateway Airports: Comparative Standing.

2010 U.S. Rank	2000 U.S. Rank	Airport (code)	CY 2000 – 2010 % change
4	5	Miami (MIA)	11.8%
5	2	Los Angeles (LAX)	-14.3%
6	7	Chicago (ORD)	-6.3%
7	3	New York (JFK)	-26.1%
9	9	Newark (EWR)	-21.0%
10	12	Atlanta (ATL)	-24.1%
11	10	Dallas/Fort Worth (DFW)	-28.5%
13	11	San Francisco (SFO)	-51.1%
14	25	Houston (IAH)	14.9%
18	22	Washington DC (IAD)	-13.4%
19	19	Seattle (SEA)	-38.0%
20	16	Boston (BOS)	-45.4%

SOURCE: Airports Council International – North America, Analysis Webber Air Cargo.

Regional Summaries

Prevailing trends affecting the U.S. air cargo industry in recent years have been predominantly national or international, such that analyses of the individual geographic regions will have similarities. Moreover, the following regional analyses will include airports already referenced as integrator hubs and international gateways but now placed within their geographic regions. Such redundancies are justified because they provide context for evaluating the opportunities and challenges confronting other airports in each region when aircraft availability is limited and legacy hubs and gateways already dominate. For each region, a group average has been calculated for cargo growth (decreases) for the period CY 2000–2010 (inclusive). External trends already explored will be cited but emphasis will be given to any trends or developments that may be unique to a region or airports therein.

Northeast

As shown in Table 4-7, the U.S. Northeast contains five airports ranked among the U.S. top twenty in 2010 air cargo tonnage, led by two airports operated by the Port Authority of New York and New Jersey. While New York JFK is home to the region's greatest diversity of international passenger carriers and all-cargo airlines, Newark Liberty serves as the regional hub of FedEx Express and a major hub for United (actually a Continental legacy hub).

Table 4-7 U.S. Northeastern Region Airports: CY 2000 – 2010 Cargo Growth.

2010 U.S. Rank	2000 U.S. Rank	Airport (code)	CY 2000 – 2010 % change
7	3	New York (JFK)	-26.1%
9	9	Newark (EWR)	-21.0%
15	15	Philadelphia (PHL)	-25.0%
18	22	Washington DC (IAD)	-13.4%
20	16	Boston (BOS)	-45.4%
32	34	Hartford (BDL)	-29.7%
35	32	Baltimore (BAL)	-56.6%
44	56	Manchester (MHT)	3.8%
46	40	Pittsburgh (PIT)	-47.4%
56	68	Harrisburg (MDT)	8.3%
69	65	Buffalo (BUF)	-33.9%
81	83	Syracuse (SYR)	-27.5%
84	87	Albany (ALB)	-32.4%
87	85	Allentown (ABE)	-43.1%
90	76	New Windsor, NY (SWF)	-63.8%
		Group	**-27.5%**

SOURCE: Airports Council International – North America, Analysis Webber Air Cargo.

Among the top twenty cargo airports, the region is also home to UPS's regional hub at Philadelphia (also a US Airways passenger hub) and international passenger gateways Washington Dulles and Boston Logan. Historical patterns of population and industry density in the Northeast established these as exceptional O&D markets, yet more recent trends have been less favorable. Traditionally the principal conduit for U.S. trade with Europe, these airports began experiencing an erosion of demand on those routes as early as the late 1990s when trade with Asia began to build rapidly. While other regions had individual strong performers, all of the top 7 airports in the Northeast experienced double-digit losses.

In the 1990s, Baltimore (BAL) sought to position itself as a less congested alternative to Washington Dulles but between CY 2000 and 2010, BAL's annual cargo dropped 56.6%, while Dulles' cargo fell only 13.4%. Boston Logan had a similarly tough period with a 45.4% drop. Pittsburgh was hit particularly hard during this period because not only did cargo drop by 47.4% it also lost a former US Airways passenger hub in favor of an even greater presence at Philadelphia. Recently, Pittsburgh International successfully added some international passenger service to Europe provided by Delta utilizing a narrow-body Boeing 757 and has hosted some international charter all-cargo flights supporting key local industry. In the late 1990s, runaway growth at airports like JFK and capacity growth limitations at JFK and other regional hubs led many communities in the Northeast to target air cargo as a source for near-term economic development. Had growth continued unabated, airports such as those in Hartford and Manchester would have been well–positioned. Instead, double-digit losses were incurred by the gateways and their would-be alternatives. Consequently, the traditional gateways are more focused on possibly replacing outdated cargo facilities than adding new capacity. Meanwhile, the second tier airports commonly have cargo facility surpluses with no near-term prospects to backfill vacancies.

Southeast

The U.S. Southeast contains only two airports ranked among the U.S. top twenty, led by Miami International Airport (MIA), which was the only major international gateway to have experienced growth in total cargo during the period CY 2000 through 2010 (Table 4-23). No other gateway so dominates a single region as MIA does Latin America, in spite of decades of efforts by others to make inroads. Among those is the region's 2nd largest cargo airport, Atlanta which hosts Delta Airlines' principal hub and is the reigning passenger leader among airports. With its incomparable international belly capacity, ATL has increased its international cargo volume. However, ATL's growth in international cargo has not been enough to offset domestic losses resulting in an overall decrease of 24.1% for the period. Still, as Delta continues to build its own international network and serves as a draw to Star Alliance partners for its hub, ATL should continue to improve its standing. Reflecting how poorly many leading airports fared during the same period, ATL's substantial decrease did not prevent it from actually rising from 12th (CY 2000) to 10th among U.S. airports in cargo totals.

As was the case with the Northeast's JFK, many had anticipated that MIA would possibly exhaust its air capacity during the current decade before the airport averaged a relatively impressive one percent growth per annum between CY 2000 and 2010. The Miami-Dade Department of Aviation is in the midst of long-term planning to facilitate cargo growth for at least the near to medium-term horizon. Should MIA reach absolute capacity, relatively land-rich ATL has competitive advantages in belly capacity to leverage in vying to be its regional successor.

While Table 4-8 suggests that as a group, the Southeast airports suffered only a 13.2% decrease compared with the Northeast's 27.5% decline, MIA accounts for more than half of the group's total cargo, masking what would have been a 30% loss without MIA's singular contribution. The region's 3rd and 4th cargo airports, Orlando (MCO) and Charlotte (CLT), suffered losses of 49.9% and 38.3% respectively. Orlando had once been projected as a possible competitor for MIA's cargo dominance but instead suffered one of the worst declines of any major gateway in the U.S. MCO's cargo facilities were built to accommodate lofty ambitions but as a consequence, likely have one of the lowest occupancy rates in the region. Similar aspirations had been suggested in the 1990s for Charlotte and Raleigh-Durham when North Carolina's economic development encouraged some area planners to champion the all-cargo Global TransPark as a potential source of relief for what were assumed to be bustling regional airports.

Table 4-8 U.S. Southeastern Region Airports: CY 2000 – 2010 Cargo Growth.

2010 U.S. Rank	2000 U.S. Rank	Airport (code)	CY 2000 – 2010 % change
4	5	Miami (MIA)	11.80%
10	12	Atlanta (ATL)	-24.10%
28	28	Orlando (MCO)	-49.90%
31	33	Charlotte (CLT)	-38.30%
36	46	Raleigh-Durham (RDU)	-21.80%
37	30	Fort Lauderdale (FLL)	-62.40%
38	50	Tampa (TPA)	-14.70%
40	57	Greensboro (GSO)	24.20%
47	59	Huntsville (HSV)	14.40%
52	41	Columbia (CAE)	-55.20%
55	62	Jacksonville (JAX)	-10.70%
65	58	Richmond (RIC)	-41.90%
73	80	Norfolk (ORF)	-0.90%
77	72	Birmingham (BHM)	-38.60%
82	89	West Palm Beach (PBI)	-17.70%
83	92	Fort Myers (RSW)	-1.90%
85	90	St. Petersburg (PIE)	-28.90%
97	94	Roanoke (ROA)	-29.20%
98	100	Charleston, SC (CHS)	59.80%
		Group	-13.20%

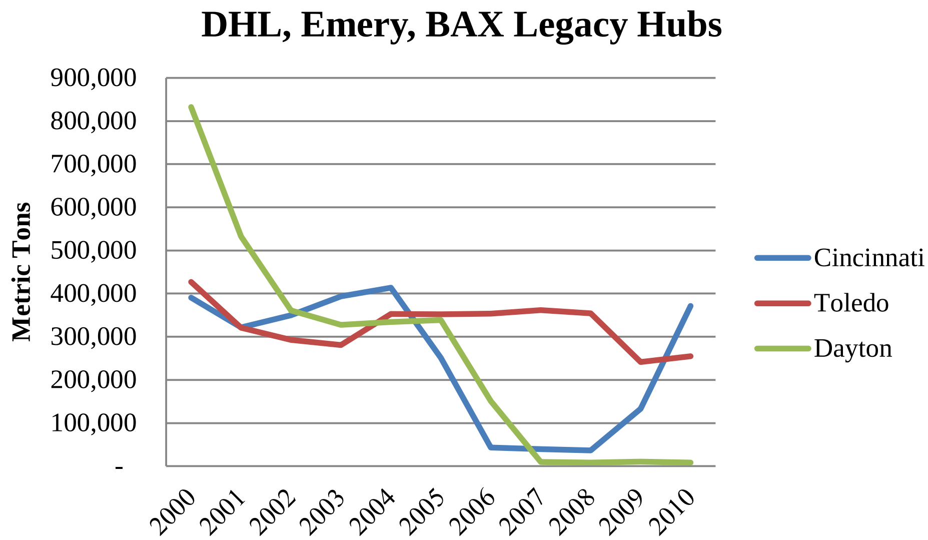
SOURCE: Airports Council International – North America, Analysis Webber Air Cargo.

A relative bright spot in the region was Greensboro with its FedEx Express mid-Atlantic hub which although smaller than originally anticipated and opposed by area constituents concerned about what its nighttime operations might do to their quality of life, gave the airport a 24.2% increase during a period when double-digit losses were the norm. Continuing one of the most unique success stories among U.S. airports, Huntsville, Alabama augmented the international service supported by the regional hub of global forwarder Panalpina. While HSV ranks only 49th among U.S. airports in total cargo, its ratio of international to domestic tonnage is likely among the nation's leaders. As a small market alternative to larger gateways, HSV is also the example most often cited by airports with similar aspirations and yet few other beneficiaries of this business model exist although many have seemingly tried.

North-Central

The U.S. North Central region covers much of the Ohio Valley which once hosted now-abandoned air cargo hubs for Emery Worldwide (Dayton), Airborne Express (Wilmington), BAX Global (Toledo) and Kitty Hawk (Fort Wayne). It also includes Cincinnati which both lost and regained a DHL hub that temporarily moved to Wilmington when DHL acquired the Airborne operation but returned to Cincinnati when DHL abandoned the U.S. domestic express market in favor of an international forwarding focus. As depicted in Figure 4-20 below, these events produced dramatic shifts. With DB Schenker's closing the former BAX hub in Toledo, a downward shift similar to Dayton's is likely.

Figure 4-20 Air Cargo for DHL, Emery, and BAX Legacy Hubs. (Data Source: Airports Council International – North America, Analysis Webber Air Cargo)



The North-Central group's 33.6% decrease does not even include the Airborne hub closure since the privately-owned Wilmington airport was not part of the reporting group of airports included in regional data but it did include the 99.0% and 93.6% declines incurred by Dayton and Fort Wayne respectively (Table 4-9). None of the region's top 14 cargo airports experienced growth during the period and only two avoided double-digit decreases.

Table 4-9 U.S. North-Central Region Airports: CY 2000 – 2010 Cargo Growth.

2010 U.S. Rank	2000 U.S. Rank	Airport (code)	CY 2000 – 2010 % change
6	7	Chicago (ORD)	-6.30%
8	8	Indianapolis (IND)	-13.10%
16	21	Cincinnati (CVG)	-5.00%
21	20	Toledo (TOL)	-40.30%
22	17	Denver (DEN)	-46.60%
24	24	Minneapolis (MSP)	-42.80%
25	26	Detroit (DET)	-35.10%
34	43	St. Louis (STL)	-20.30%
39	38	Kansas City (MCI)	-42.20%
43	45	Cleveland (CLE)	-33.30%
45	49	Milwaukee (MKE)	-28.40%
48	52	Columbus (LCK)	-27.50%
49	47	Omaha (OMA)	-39.20%
53	48	Des Moines (DSM)	-49.50%
68	75	Grand Rapids (GRR)	6.60%
75	78	Sioux Falls (FSD)	-14.90%
76	88	Chicago Midway (MDW)	21.40%
79	81	Cedar Rapids (CID)	-20.00%

2010 U.S. Rank	2000 U.S. Rank	Airport (code)	CY 2000 – 2010 % change
88	82	Peoria (PIA)	-52.80%
89	97	Springfield, MO (SGF)	1.00%
93	35	Fort Wayne (FWA)	-93.60%
94	95	South Bend (SBN)	-19.70%
95	96	Madison (MSN)	-17.00%
96	86	Colorado Springs (COS)	-55.60%
101	13	Dayton (DAY)	-99.00%
		Group	**-33.60%**

SOURCE: Airports Council International – North America, Analysis Webber Air Cargo.

Notwithstanding such widespread decreases, the North-Central region hosts more (25) airports ranking in the U.S. top 101 by a substantial margin. Among top ten cargo airports, the region is anchored by international gateway Chicago O'Hare and FedEx's second largest North American hub in Indianapolis. DHL's Cincinnati hub moved up from 21st in CY 2000 to 16th in 2010. Not included only because the airport does not report annual tonnage to ACI-NA, UPS regional hub in Rockford, IL would likely also rank in the lower end of the top twenty.

In addition to the region's dominant international gateway in Chicago, the region also hosts two former Northwest Airlines (now Delta) hubs with service to Asia and Europe in 24th Minneapolis and 25th Detroit. While both suffered substantial losses (-42.8% and -35.1%, respectively), the direct international flights still provide competitive advantages against other airports in the region lacking hubs. In addition to the FedEx Express hub, Indianapolis also hosts international freighters from European carrier Cargolux serving the area's time-sensitive pharmaceutical companies. In early 2012, Detroit's revived automobile industry was cited as critical to a decision by Lufthansa Airlines to add freighters to complement its existing passenger service at DTW. Other passenger hubs in the region include 22nd Denver (United) and 43rd Cleveland (United, formerly Continental). While not full-fledged regional hubs, FedEx Express and UPS have substantial regional operations in Columbus (all-cargo Rickenbacker) and Des Moines. In spite of the losses, including hub closures, the region still has an incomparable concentration of top 100 airports, as well as passenger and cargo hubs. For airports depending on air cargo for future development, the competition within the region is extraordinary. Even more daunting, a decade's worth of cargo losses has left tremendous surplus cargo facilities capacity, including vacant hubs.

South Central

The U.S. South Central region includes the national hubs of FedEx Express and UPS – 1st Memphis and 3rd Louisville. The next six largest cargo airports in the region are all located in Texas, led by Dallas/Fort Worth which is aided both by its American Airlines passenger hub and a UPS regional hub, as well as a variety of international carriers that include a growing presence of Asian airlines. Houston (IAH) rose from 25th to 14th between CY 2000 and 2010 and had a 14.9% increase in cargo which can be attributed to the presence of energy-related industry as well as a United (formerly Continental) Airlines hub with a strong Latin American network. As a group, the South Central airports enjoyed a 25.3% increase but without the Memphis and Louisville hubs the region would have suffered a

21.8% decrease. The region also includes the previously described FedEx Express regional hub at Alliance Fort Worth.

Beyond the air cargo hubs and international gateways, the next three largest airports in the region are Texas airports San Antonio (32nd), El Paso (42nd) and Austin (50th). San Antonio and Austin compete directly against one another with express carriers rationing their networks as UPS now does in serving Austin only with overnight service while less time-sensitive shipments for Austin's industry is mostly served by truck from San Antonio. Such network adjustments are responsible for San Antonio rising from 44th to 30th among U.S. airports between CY 2000 and 2010, even as Austin fell from 37th to 50th. The balance of shipper demand has tilted from favoring Austin's high-tech industry to San Antonio's manufacturers. Both markets, as well as El Paso (42nd), also are affected by trade with Mexico which has suffered economically.

The region also includes New Orleans International Airport (MSY), which suffered the unique calamity of Hurricane Katrina. Some attribute MSY's challenging decade (-39.1%) to the economic hardships of that disaster and yet that decline was no worse than those suffered by Austin (-57.2%), Alliance Fort Worth (-47.6%) and Oklahoma City (-40.2%). The region also includes Nashville which suffered losses of such key demand-drivers as Dell Computers manufacturing operation that once supported scheduled international freighters to Asia but ended the decade ranked below in-state rival Knoxville (Table 4-10).

Table 4-10 U.S. South-Central Region Airports: CY 2000 – 2010 Cargo Growth.

2010 U.S. Rank	2000 U.S. Rank	Airport (code)	CY 2000 – 2010 % change
1	1	Memphis (MEM)	57.40%
3	6	Louisville (SDF)	42.60%
11	10	Dallas/Fort Worth (DFW)	-28.50%
14	25	Houston (IAH)	14.90%
29	30	Fort Worth (AFW)	-47.60%
30	44	San Antonio (SAT)	-0.70%
42	53	El Paso (ELP)	-12.50%
50	37	Austin (AUS)	-57.20%
57	54	New Orleans (MSY)	-39.10%
59	64	Tulsa (TUL)	-8.40%
63	71	Knoxville (TYS)	-4.50%
64	63	Nashville (BNA)	-31.30%
71	66	Oklahoma City (OKC)	-40.20%
72	79	Shreveport (SHV)	0.70%
78	84	Wichita (ICT)	-8.60%
91	101	Lafayette (LFT)	833.90%
92	98	Houston Hobby (HOU)	44.70%
		Group	**25.30%**
		Group (less MEM & SDF)	**-21.80%**

SOURCE: Airports Council International – North America, Analysis Webber Air Cargo.

Northwest

The Northwest region includes FedEx's western hub at Oakland International Airport (12th), major international gateway San Francisco International Airport (14th) and two lesser international gateways in Seattle (19th) and Portland (26th). None rank in the top ten of U.S. cargo airports and only three ranked in the top twenty. All four plus the only other airport in the region to rank among the top fifty – 27th Salt Lake City – suffered severe double-digit decreases between CY 2000 and 2010.

Only thirteen Northwest region airports rank in the top 100 and as a group, the region's airports suffered a collective decline of 41.1% – the worst loss of any of the six regions in this analysis. San Francisco and other airports supported by Silicon Valley (San Jose) felt the impact as software once shipped in so-called jewel box cases gave way to downloads (Table 4-11). This form of 'modal substitution' was less conventional than the losses transpacific gateways were already suffering as pricier air transport was being replaced with slower, cheaper ocean transport. While Sacramento's principal commercial airport did enjoy 9.0% growth, the airport once proposed as its all-cargo alternative – Sacramento Mather – suffered a 77.6% decrease, suggesting that the Sacramento market was, on balance, as deflated as the rest of the region. Seattle and Portland have ambitiously pursued – with occasional success – international air service competing not only against one another but also against Vancouver, Canada's nearby transpacific gateway.

Table 4-11 U.S. Northwest Region Airports: CY 2000 – 2010 Cargo Growth.

2010 U.S. Rank	2000 U.S. Rank	Airport (code)	CY 2000 – 2010 % change
12	14	Oakland (OAK)	-25.50%
13	11	San Francisco (SFO)	-51.10%
19	19	Seattle (SEA)	-38.00%
26	27	Portland (PDX)	-32.60%
27	29	Salt Lake City (SLC)	-43.30%
51	60	Sacramento (SMF)	9.00%
60	39	San Jose (SJC)	-69.70%
62	61	Spokane (GEG)	-29.10%
66	36	Sacramento Mather (MHR)	-77.60%
67	70	Boise (BOI)	-20.20%
80	77	Fairbanks (FAI)	-35.70%
99	91	Fresno (FAT)	-54.70%
100	99	Casper (CPR)	27.50%
		Group	**-41.10%**

Source: Airports Council International – North America, Analysis Webber Air Cargo

Southwest

The Southwest region includes the dominant transpacific gateway Los Angeles International Airport, which also hosts what FedEx Express describes as a Metro hub only 30% smaller than its West regional hub in Oakland. For perspective, in 2010 LAX accounted for almost as much total tonnage as all thirteen airports grouped in the preceding Northwest airports section. While LAX suffered a 14.3% cargo decrease between CY 2000 and 2010, the airport actually experienced international growth – often at the expense of other western airports such as San Francisco that lost freighters as carriers consolidated their operations around LAX. The region also includes LA/Ontario International Airport which hosts the UPS western region hub and is managed by the same operator – Los Angeles World Airports (LAWA) – as LAX. Underscoring the difficulty of developing alternative international gateways, LAWA attempted to shift some international carriers from LAX to ONT but could not do so during a period when the principal gateway was suffering a decline (Table 4-12). Among southwestern airports, only LAX and ONT ranked among the U.S. top twenty. With Phoenix (23rd), San Diego (33rd) and Las Vegas (41st), all of the region's airports ranking in the top fifty suffered double-digit losses. The region's eighth largest cargo airport (U.S. 58th), Reno-Tahoe, fared relatively well by ending 2010 with virtually the same annual tonnage as it had in CY 2000.

Table 4-12 U.S. Southwest Region Airports: CY 2000 – 2010 Cargo Growth.

2010 U.S. Rank	2000 U.S. Rank	Airport (code)	CY 2000 – 2010 % change
5	2	Los Angeles (LAX)	-14.30%
17	18	Ontario (ONT)	-23.30%
23	23	Phoenix (PHX)	-33.20%
33	42	San Diego (SAN)	-17.10%
41	51	Las Vegas (LAS)	-17.00%
54	55	Albuquerque (ABQ)	-34.70%
58	67	Reno (RNO)	0.30%
61	74	Burbank (BUR)	18.00%
70	73	Tucson (TUC)	-18.30%
74	69	Long Beach (LGB)	-46.90%
86	93	Santa Ana (SNA)	-13.10%
		Group	**-20.00%**

SOURCE: Airports Council International – North America, Analysis Webber Air Cargo.

SUBTASK 1.4: AIR CARGO PERSONNEL AND CULTURE

Key Players on Airports and Within the Air Cargo Industry

The air cargo industry is a service industry providing shippers with transportation of their products, goods and materials. Unlike passenger transport whose customers typically travel round trip on aircraft, air cargo packages and parcels are one-way shipments. The industry obviously utilizes aircraft for their operations but also relies heavily on wide range of truck types. The industry is also heavily regulated, is labor intensive, and operates on a 24-7 schedule. Workers within the industry have a wide range of educational attainment from pilots who have college degrees and thousands of hours of flight time, to ramp workers and clerks who have high school diplomas and vocational training. Some air cargo businesses have organized labor while others do not. Labor unions often represent pilots, ramp workers, and truckers, depending on the air cargo business' agreements with organized labor. The industry, in general, is profit focused and will only operate aircraft at an airport when it is deemed profitable to the company's bottom line. It is also important to point out that the air cargo industry, particularly on the aviation side of the business, is heavily regulated by the federal government.

The airport industry is a transportation utility which, in the U.S., is often publicly owned and operated. Airport management focuses on aviation business success as well as the safety of the flying public and aviation businesses. Airports are often focused on the bottom line and some are self–funded, requiring no subsidies from the municipal government with which they may be affiliated. Other airports require subsidies, which can come from the municipal governments' public works budget or federal programs, such as the FAA's Airport Improvement Program (AIP) or the Essential Air Service (EAS) Program. About half of the commercial service airports in the U.S. operate as airport authorities and have separate powers from the local municipality or county in which they are located. Airport authorities operate on independent budgets and are not subsidized by local jurisdictions. Airports are heavily regulated by the FAA and must comply with a wide range of aviation safety and environmental rules. Airport personnel provide a variety of functions which impact air cargo activity. Among others, these positions are listed below.

- Airport Director
- Airport Planner
- Airport Marketing Manager
- Airport Properties Manager
- Air Transport Pilot
- Loadmaster
- Ramp Agent
- Ramp Operations Manager
- Aircraft Fueler
- Aircraft Mechanic
- Vehicle Mechanic
- Dispatcher
- Warehouse Agent
- Cargo Sales Agent
- Export/Import Agent
- Transportation Scheduler
- Flight Operations Controller
- Load Planning Coordinator
- Sort Laborer
- Courier
- Truck Driver

SUMMARY

Chapter 4 represents an overview of the air cargo industry. It primarily focused on air cargo activities at airports, facility planning, facility finance and funding, air cargo trends in the U.S., and the culture and staff found within the air cargo industry. The chapter focused on three components on the air cargo industry: air cargo carrier activity at airports, air cargo facility development and funding at airports, and air cargo industry trends. Several characteristics and features are outlined for each component. For air cargo carrier activity, the different types of cargo airlines, aircraft, airports, facilities, and buildings found throughout the air cargo industry were identified to provide insight into the functionality of the industry's components. The air cargo facility development and funding overview demonstrates the means by which air facilities are established on airports and the handling systems that operate within them. The next chapter outlines the data collection process as part of this study which is used to determine throughput ratios. The data collection provides the necessary steps an airport planner needs to take when conducting the air cargo facility planning element of an airport master plan.

CHAPTER 5: TASK 3—DATA COLLECTION PLAN, FIELDWORK AND INVENTORY PROCESSES

CHAPTER OVERVIEW

This technical report explains the ACRP 03-24 study data collection plan and implementation. The research team used a two-prong approach in the data collection task. First, the team used a case study approach focusing on select airports representing a range of airport types; second, a system wide data collection from airport management via a survey effort was also used. Both efforts included collecting samples from international gateways, major hub airports, and origin and destination (O&D) airports. Surveys were designed and tested with airport participation and air cargo business inputs. Interviews were held at all case study airports with airport planners and properties managers. This report provides detail on the data collection plan, fieldwork and inventory processes.

INTRODUCTION

The objectives of Task 3 are to collect data representative of a range of airports, identifying the type and size of facilities comprising the existing air cargo marketplace. This report provides an overview of Sub Task 3.1 which is the planning steps taken by the research team to collect data related to air cargo facilities on a wide variety of airports in the U.S. This data will be used as a basis for exploring new cargo planning metrics. Data was gathered from international gateway, major domestic, integrated carrier hubs, and small regional facilities, and includes an inventory of cargo facilities at these airports by type, size, and throughput.

SUBTASK 3.1: DATA COLLECTION PLAN

The research team used a two-prong approach in the data collection task. First, the team used a case study approach focusing on select airports representing a range of airport types; second, a system wide data collection from airport management via a survey effort was used. Both efforts included international gateways, major hub airports, and origin and destination (O&D) airports.

Case Study Approach

In the amplified work plan we originally proposed to the panel to collect data from 14 specific case study airports related air cargo facility and throughput data. The number of airports was increased to 16 case study airports. The rationale for adding two more airports will be discussed subsequently. The 2002 ACI Air Cargo Facility & Security Survey, separated airports into three groups of which the research team followed suit. These airport size breakouts include:

- Large cargo centers – 500,000 or more metric tons (3 airports)
- Medium cargo centers – 100,000 – 499,999 metric tons (6 airports)
- Small cargo centers – 100,000 or less metric tons (7 airports)

In addition to defining airports for case studies by size, the research team identified airports by roles they fulfill in the national system of airports. These roles ranged from international gateway airports which support the air cargo industry with wide-body passenger airlines as well as all-cargo freighter operators. For purposes of this study international gateways were defined as airports with scheduled wide-body international passenger service by more than one passenger airline and/or airports with international wide-body freighter service on a daily basis.

Case Study Airport Selection – Our team member's geographic locations placed them in proximity to hub airports in the Ohio Valley (DHL-CVG, Rickenbacker-Columbus, and FedEx-IND), Chicago O'Hare, Milwaukee, Kansas City, Des Moines (UPS Regional hub) in the Midwest, Austin, San Antonio, Houston in Texas and Spokane and Seattle in the Pacific Northwest. These airports near our team's multiple bases provided maximum use of resources and allowed other targeted case study airports to be included in more distant markets.

Figure 5-1 Location of Case Study Airports. (SOURCE: CDM Smith.)

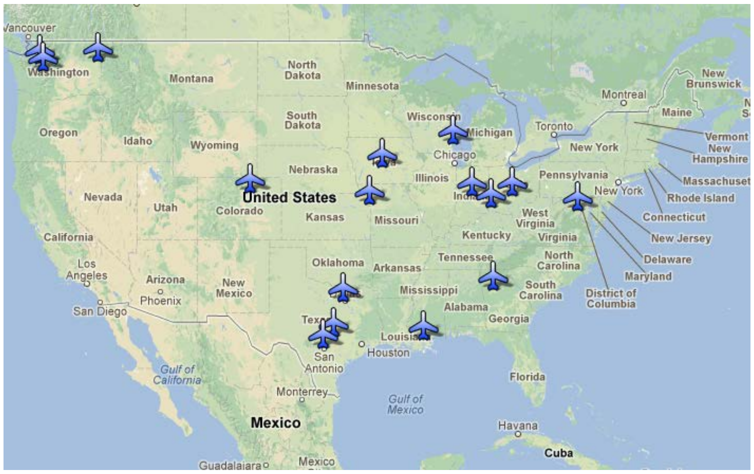


Table 5-1 identifies the case study airports. These range from international gateway airports (ATL, SEA, DFW, and IAD) supporting tremendous passenger and cargo throughput to passenger hub airports where at least one passenger airline operates a hub and spoke system (CVG, DEN, MCI). Additionally, airports with national or regional cargo hubs (IND, BFI) were surveyed as well as airports that are strictly an origin and destination passenger market (DSM, MSY, AUS, SAT, GEG, MKE). Two airports functioning as an alternative international gateway were analyzed (LCK, IND). Alternative international gateway airports are defined as airports with more than one scheduled wide-body freighter aircraft per week. DFW was initially considered as a case study airport then we, the research team, switched it to Houston Intercontinental given its rapid growth in cargo activity and facilities. Houston Airports Systems, however, had to decline to participate due a huge terminal/airline project announcement at Houston Hobby. As a result, Houston Intercontinental Airport was then dropped as a case study airport and Dallas Fort Worth, fortunately, agreed to participate.

As stated, two airports were added to the case study airports field work. King County International Airport/Boeing Field was added to the analysis due to its strategic location in the Seattle market area and its function as a viable alternative to SEATAC. King County International Airport (BFI) is one of the busiest airports in the nation, serving more than 259,913 aircraft operations in 2010 with recreational, corporate, military, and Boeing jet aircraft. The Airport is also home to major Boeing manufacturing facilities. BFI is the base for approximately 150 businesses including air cargo companies, flight schools, charter operations and helicopter services. In 2011, BFI handled 115,000 metric tons of air cargo and enplaned approximately 30,000 passengers. The airport provides limited passenger service and is one of two primary air cargo airports in the region since UPS and DHL operate cargo jet and turboprop feeder aircraft at the airport. Kansas City International Airport was added to the list of case study airports because of familiarity of the airport to the research team. Additionally, only a few years ago the airport signed a master development contract for a logistics park on airport property for a traditional rail and trucking hub. This activity plus traditional UPS and FedEx Express activity at the airport create an interesting and complex environment.

Table 5-1 Air Cargo Case Study Airports.

Airport	Market	FAA Class.	2010 Metric Tons	ACI Cargo Grouping
International Gateways				
Atlanta Hartsfield Jackson Int'l(ATL)	Atlanta	Large Hub	659,129	Large
Dallas Fort Worth Int'l (DFW)	Dallas	Large Hub	645,426	Large
Seattle-Tacoma Intl (SEA)	Seattle	Large Hub	283,425	Medium
Alternative International				
Rickenbacker Intl (LCK)	Columbus	Non Primary CS	69,748	Small
King County/Boeing Field (BFI)	Seattle	Primary NonHub	115,000	Medium
Indianapolis Intl (IND)	Indianapolis	Medium Hub	1,012,589	Large
Passenger Hub				
Washington Dulles Intl (IAD)	D.C.	Large Hub	332,275	Medium
General Mitchell (MKE)	Milwaukee	Medium Hub	78,269	Small
Denver Intl (DEN)	Denver	Large Hub	251,777	Medium
Air Cargo Hub				
Spokane Intl (GEG)	Spokane	Small Hub	43,251	Small
Des Moines Intl (DSM)	Des Moines	Small Hub	56,824	Small
Cincinnati/Northern Kentucky Intl (CVG)	Cincinnati	Medium Hub	371,297	Medium
O&D Airport				
Austin Bergstrom Intl (AUS)	Austin	Medium Hub	69,397	Small
San Antonio Intl (SAT)	San Antonio	Medium Hub	123,788	Medium
Louis Armstrong-New Orleans Intl (MSY)	New Orleans	Medium Hub	52,604	Small
Kansas City Intl (MCI)	Kansas City	Medium Hub	87,092	Small

SOURCE: CDM Smith.

Case study airports goals and objectives – The goal of the case study airports is for research team members to collect data from airport planners and management, interview key cargo related tenants regarding their facilities and operations and if appropriate meet with off airport cargo businesses such as air forwarders. Air cargo businesses included international and domestic passenger carriers, all cargo carriers, cargo ground handling support entities such as Menzies or Swissport, and if possible government agencies supporting air cargo operations. The goal was to obtain a wide sampling, as well as unique data that may only be captured from this personal interview process. Data provided at the case study level was key in obtaining detailed information on facility utilization by tenant type. Additionally, the case study airports data collection approach is more representative of the airport master planning process and will provide the basis for the guidelines development.

Case study airport participation – One of the key challenges to the data collection effort, particularly the development of the case study airports subtask, was the preparation of the case study list and approaching airport leadership to invite them to participate. Each airport on the case study list was contacted by the team member assigned to visit the airport. A cover letter was developed for team members to distribute during their initial contacts to invite airport management to participate. Some team members already had business relationships with the case study airports they were assigned to visit. Other team members had little to no established relationships within their assigned airports which necessitated reaching out to airport management on their own or with assistance from other team members which had contacts at these airports.

Case study airports were contacted between April and June to request their participation in the ACRP 03-24 study. Airport management for all 16 case study airports agreed to participate in the study. Once they agreed to participate, personnel at the airport assigned to assist the research team were contacted by email, sent an ACRP 03-24 Airport Planning Department Survey, and asked to provide a date and time to meet at their airport. Initially the Airport Planning Department Survey requested a response time of 10 days for completion but many airport planners completing the survey asked for three to four weeks to complete the survey prior to the project team visit. Scheduling visits also was challenging as coordinating with airport planners' busy schedules as well as coordinating with key on-airport cargo businesses necessitated scheduling well in advance. We also found that it was important to get full backing of case study airports and have management announce the study to airport air cargo tenants preferably on airport letterhead, newsletter or emails. Most airport management representatives chose to call ahead for us or send an email. This helped to coordinate with on-airport air cargo businesses and legitimizes the air cargo business participation requests.

Case Study Airport/Field Work Test – Austin Bergstrom International Airport (AUS) was chosen as the first case study airport to test the Airport Planning Department Survey and the Air Cargo Business Survey. The rationale for choosing AUS was that Lynxs Group is based in Austin and has extensive contacts with airport management and air cargo related tenants on the airport. The case study airport test at AUS was conducted in mid-April. Prior to the time the field work at case study airports began several surveys were developed. Details in the survey development will be presented subsequently, but in short, members of the research team developed the Airport Planning Department Survey and the Air Cargo Business Survey and several members of the project panel reviewed the questions and cover letters and commented over a course of several weeks in March and April. The surveys included the Airport Planning Department Survey and Air Cargo Business Survey.

The Airport Planner at AUS provided input on the Airport Planning Department Survey during a scheduled 1-hour interview. In attendance at the interview were members of the research team and the landlord and owner of several cargo buildings at AUS. Mr. Medici provided his completed survey which was jointly reviewed by the research team question-by-question. He also provided his insights on the Air Cargo Business Survey. One concern he raised was the survey length for both surveys. Lynxs' staff arranged interviews of air cargo businesses at the airport all of which are tenants of Lynxs. Air Cargo Businesses interviewed that day included DHL, FedEx Express, and Menzies. All three completed the survey and critiqued it. Menzies' inputs were minimal however due to the nature of their contract operations for passenger airlines at AUS and limited air cargo activity. Additionally, the interview team met with representatives from the local chamber of commerce and economic development agency to make them aware of the study and gather their insight on business development in the region. A brief report on the findings of the AUS field work is presented subsequently as will be reports for all case study airports.

Survey Revisions – After the initial field work at AUS, members of the research team rewrote survey questions and rearranged ordering of questions for both surveys based on comments received from the airport planner and cargo businesses at AUS. Panel member comments were incorporated into the final version of the surveys as well.

Database Development – Prior to the field work, research team members developed several databases for the project based on internet research and in-house files. These include:

- Lists of top air forwarders located at case study airports
- List of cargo businesses and government agencies located at case study airports
- Lists of third party building developers at case study airports
- Contact list for all airports to be given an Airport Planners Survey
- Aerial photos of cargo buildings on case study airports

Field Work – After the survey tools were finalized survey efforts began in earnest. Case study airports were contacted by phone or email to confirm their participation in the study. Table 5-2 identifies the airports included in the Case Study airports and the dates for data collection and interviews. Also, given a team member's proximity and familiarity with Kansas City International (MCI) we included this airport as an additional case study airport. BFI airport was included in the SEA field work visit. Prior to having individual team members depart into the field a series of conference calls took place with team leaders discussing the best methods of data collection to insure proper techniques and consistency in the data collection effort as well as a standard approach in documentation.

Table 5-2 Air Cargo Case Study Airports – Team Assignments.

Airport Code	Interview Date
AUS	April 18
DSM	April 25
ATL	May 10-12
DEN	May 16-17
MSY	May 29
DFW*	May 30
GEG	June 26
MCI	June 26
MKE	July 13
LCK	July 25
SAT	July 27
IAD	August 9
CVG	August 8
IND	August 16
SEA/BFI	September 12-14

SOURCE: CDM Smith.

Cargo associations meetings – During his field work visits, Michael Webber spoke to two air cargo associations at their monthly meetings in Atlanta and New Orleans. At these meetings he discussed the importance of the ACRP 03-24 study and encouraged air forwarders to complete the Forwarders survey. Mike Maynard presented an update on the study at the ACI Annual Conference in Calgary, Alberta, Canada.

Airport visits preparation – The research team conducted desktop research on the select case study airports prior to going into the field. This research included reviewing air cargo carrier schedules, cargo aircraft type operating at the airport and specific locations of air cargo facilities. Aerial photos of the airport by Google Earth Pro and Bing Maps online websites were helpful in preparing for field visits. Many of the team members used airport air photos during our discussions with airport planners and air cargo business representatives, marking them with facility information and notes. Folders with completed surveys, contact information, aerial photos, cargo business lists, and airport master plan schematics were compiled and taken into the field by team members.

Field visits results – The research team conducted an inventory of cargo facilities at the case study airports via on-site visits. The visits included meeting with airport planning staff followed by face-to-face interviews of air cargo tenants. Data gathered focused on airside and landside components, each facility by type, size, and annual cargo throughput if available.

- storage facilities
- warehouse and office space
- processing space
- specialized services (including refrigeration and climate-controlled facilities)
- sorting equipment
- parking spaces (aircraft and truck) and gates

- fueling, deicing, and other servicing facilities
- ramps and docks
- off-airport facilities
- access and egress components
- security and customs clearance facilities; and others, as appropriate

Information on the attributes of each facility were collected such as: age of the structure, its original purpose, number of truck docks/gate access, the type of tenant and the type and density of commodities commonly handled. Additional data will include whether the facility has storage racks, slides and conveyors for sortation, ceiling height, equipment use (forklifts, belt loaders) roller floors, ULD storage, outside equipment (K loaders, tugs, dollies), and aircraft parking positions.

System-Wide Data Collection

The research team designed and implemented the Airport Planning Department Survey to collect air cargo data not only from case study airports but airports in the U.S. with scheduled air cargo service. This survey effort was system wide gathering data from ACI member airports which represent a wide range of airports in size and characteristics such as international gateway and major hub airports as well as O&D airports. The system wide airport distribution list was developed by a review and analysis of air cargo facility data collected by an ACI-NA airport facilities project. This ACRP 03-24 study is designed to update cargo facility data previously gathered during a 2002-2003 survey effort. The previous list was expanded to include airports in a variety of geographic locations. The list of airports currently included in the distribution is highlighted in Table 5-3. Of the 55 system wide airports invited to participate in the ACRP 03-24 study by completing the Airport Planner Survey, 16, or 29%, chose to complete and return the survey. Four airports have yet to return their survey but have promised to do so. When combining the results of the 55 system wide airports with the results of the 15 case study airports, the response rate is a total of 31 completed Airport Planning Department Surveys representing a 44% response rate overall to the survey effort.

For this effort surveys were distributed via email to Airport management planning and properties departments. In order to obtain a high response rate, each survey was designed to be understandable, gather information which does not require onerous research by the respondent and be user friendly. Surveys allowed the respondent to return the survey via email. Serious consideration was given to have the Airport Planning Department Survey made available online through an online vendor, but the team decided not to pursue this route as the airport planner at our test airport indicated these types of survey are often completed by more than one person within an airport organization. A separate paper or electronic survey works best for circulating amongst several respondents.

Most non-responsive airports were contacted by telephone or email a second time to encourage their participation. If they had not responded after the second contact it was assumed they would not participate. We found airports where the research team members had an ongoing working relationship were the most helpful in completing the surveys.

Data Collection Survey Tools

Since this project focuses on air cargo facilities, specifically the development of new planning metrics in their design, survey tools were developed to gather information on the utilization and traffic flow related to on airport air cargo buildings. Two surveys were developed which included a survey of airport management and a survey designed to gather information from private sector air cargo businesses. Given the sensitivities of a government sponsoring study gathering data from private sector business all surveys were carefully vetted to ensure no needlessly commercially intrusive questions were asked.

Airport Planning Department Survey – Survey Design – The Airport Planning Department Survey was developed by the research team to provide data on-airport cargo facilities, operations, and plans related to air cargo activity at case study airports as well as participating system airports. See Appendix A for the survey and cover letter. Although the survey was titled Airport Planning Department Survey, the study team understood that airport planners, properties managers, marketing staff and airport air cargo managers would likely complete the surveys and so were designed with this wider respondent audience in mind.

The survey was divided into two parts. Cargo Activity PART I focused on collecting data related to air cargo volume and traffic. The survey begins by collecting general airport information and information on those assigned to complete the survey. The survey then targets data collection by 17 questions related to the number of airlines and cargo carriers operating at the airport, as well as the tonnage statistics attributable to all cargo carriers. The survey then requests information on domestic enplaned and deplaned tonnage by passenger and cargo carriers as well as international enplaned and deplaned tonnage by passenger and cargo carriers. The survey then collects data, over 8 questions, related to cargo buildings and areas such as location of facilities, aircraft utilization, facility size and layout. The survey then continues on with 12 questions regarding Air Cargo Facility Plans and three questions on Environmental Factors.

PART II of the survey continues to focus on collecting data related to air cargo activity but with an emphasis on air cargo facility utilization. Since airports often have more than one cargo building we asked respondents to complete questions 2.1 through 2.15 for each cargo building. If there were more than three cargo buildings at the airport, we asked respondents to reproduce questions 2.1 to 2.15 of the survey for each additional cargo building. Questions in Part II focused on facility size, ownership (airport owned, third party developer, and cargo carrier), ramp size and location, space designated for GSE, aircraft parking, and operations, as well as gate access and number of tenants in the building.

The next section of the survey requested airport respondents to provide a list of air cargo businesses located on the airport and there contact information. Key cargo businesses located on case study airports were contacted to gather information on their facility via an Air Cargo Business Survey as well as to set up a time for an interview.

The last three questions – Survey Tool Assessment – on the survey requested airport respondents to surmise the length of the survey and the number of questions. Respondents were asked how many minutes the survey took to complete.

Table 5-3 System Airports Invited to Participate in ACRP 03-24 Surveys.

Code	Airport Name	Emailed Response	Survey Completed
ABQ	Albuquerque International	Yes	Yes
ANC	Ted Stevens Anchorage International Airport	Yes	Yes
BFI	Boeing Field	Yes	Yes
BHM	Birmingham-Shuttlesworth International	No response	
BNA	Nashville International Airport	Yes	Yes
BTR	Baton Rouge Metropolitan Airport	No response	
BTV	Burlington International Airport	No response	
BWI	Baltimore/Washington International Airport	Yes	Yes
CAE	Columbia Metropolitan Airport	No response	
CID	The Eastern Iowa Airport	Yes	
CLE	Cleveland-Hopkins International	No response	
DAY	Dayton Intl	No response	
DLH	Duluth International	Declined	
ELM	Elmira/Corning Regional Airport	No response	
ELP	El Paso International Airport	No response	
ERI	Erie International Airport	No response	
EWR	Newark Liberty Intl Airport	Yes	
FAI	Fairbanks International Airport	Yes	Yes
FLL	Fort Lauderdale/Hollywood International	No response	
FWA	Fort Wayne International Airport	Declined	
GFK	Grand Forks	No response	
GSP	Greenville-Spartanburg International	Yes	Yes
GTF	Great Falls Intl	No response	
HLN	Helena Regional Airport	No response	
HSV	Huntsville International Airport	No response	
IWA	Phoenix-Mesa Gateway	No response	
JAN	Jackson-Evers International	Yes	Yes
JAX	Jacksonville International Airport	Yes	Yes
JFK	John F. Kennedy International	Yes	
LAN	Capital Region International Airport	No response	
LAX	Los Angeles International Airport	No response	
LGA	LaGuardia Airport	Yes	
MEM	Memphis International Airport	Considering	
MHR	Mather Airport	Forwarded internally	
MIA	Miami International Airport	Declined	
MSP	Minneapolis-St. Paul International	No response	
OAK	Metropolitan Oakland International	Yes	Yes
OKC	Will Rogers World Airport	No response	
ORD	Chicago O'Hare International Airport	No response	
PDX	Portland International Airport	No response	

Code	Airport Name	Emailed Response	Survey Completed
PHL	Philadelphia International Airport	Yes	Yes
PHX	Phoenix Sky Harbor International	Yes	Yes
PIT	Pittsburgh International Airport	Declined	
PVD	Theodore Francis Green State Airport	No response	Yes
PWM	Portland International Jetport	No response	
RNO	Reno-Tahoe International Airport	Yes	
RSW	Southwest Florida International Airport	Yes	Yes
SAN	San Diego International Airport	No response	
SDF	Louisville Regional Airport Authority	Yes	Yes
SLC	Salt Lake City International	No response	
SMF	Sacramento International Airport	Forwarded internally	
STL	St Louis Lambert International Airport	Yes	Yes
TPA	Tampa International Airport	No response	
TUL	Tulsa International Airport	Declined	
TVF	Thief River Falls Regional	No response	

SOURCE: CDM Smith.

Distribution of Airport Planning Department Surveys – The Airport Planning Department Survey was distributed to the 15 case study airports via email after they had agreed to participate. Personnel were emailed an Airport Planning Department Survey and were requested a response time of 10 days for completion. Many airport planners assigned to complete the survey indicated they would need three to four weeks to complete the survey due to work load issues. A list of 55 system wide airports was developed, in addition to the 15 case study airports, and each was contacted to request their participation in the ACRP 03-24 study by completing the Airport Planning Department Survey. This invitation consisted of an email introduction to the study, a pdf cover letter for the survey and the survey in pdf form. The response rate with case study airports was 100%, but only 29% amongst the system wide outreach. Generally speaking, airports with the more cargo buildings took longer to respond since questions with 2.1 to 2.15 had to be answered for each cargo facility. This may have also impacted the lack of response rates to the survey as the length of the questionnaire may have swayed their participation decision. It is also noteworthy to point out that several airport respondents' forwarded questions 2.1 to 2.15 to their air cargo businesses on the airport to complete. Anecdotal information from respondents indicates they felt the tenants knew the facilities best and could complete it with relative ease. Airports contacted for this study were not instructed by the research team to collect data in this manner.

Air Cargo Business Survey – The Air Cargo Business Survey was developed by the research team to provide data on cargo activity, on-airport cargo facilities, operations, and plans related to air cargo activity at case study airports as well as participating system airports. The survey was designed to be completed by a wide range of cargo operators on an airport such as passenger airlines, integrated express (FedEx, UPS, DHL, etc.), cargo-only carrier/freighter, air freight forwarder, 3PL providers, regional air cargo carrier (Contractor) and ground handlers. See Appendix A for the survey and cover letter.

The survey was comprised of over 40 questions with the first section gathering information on general air cargo information and contact information for the person completing the survey. The survey then targets data collection on cargo activity with three questions followed by 21 questions asking detailed questions regarding their facilities and operations. The questionnaire delves further into airside facilities with six questions covering truck parking, aircraft operations, ramp space, and GSE storage. The survey was also designed to collect data on cargo activity such as inbound and outbound volumes, peak hour activity, and facility constraints. The final two sections of the survey collected data on whether the air cargo business responding to the survey had undertaken any environmental initiatives related to air quality and energy consumption. The survey also inquired about the use of communications technology. The survey was tested and commented on by UPS Properties Department staff, FedEx Express staff at AUS and DHL staff at AUS. After their review the survey was broadcast via email to the specific air cargo businesses or hand delivered during the field work.

Distribution of Air Cargo Business Survey – The research team used a two-prong approach to distribute the Air Cargo Business Survey. The first effort was to get the surveys to local air cargo business located on the case study airports. Airport management supplied the list of air cargo businesses located on their respective airport. The team also developed a list of air cargo businesses based on lists of businesses that rent from third party developers such as Lynxs, ProLogis and Aeroterm. Airport supplied air cargo business lists were verified by researching market specific air cargo association's membership lists such as the Seattle-Tacoma Air Cargo Association. Prior to conducting visits to case study airports, team members made a goal of interviewing six to eight air cargo businesses per airport. When arranging to meet with air cargo businesses the team found there was some hesitation by many large national cargo firms. Since the industry market share is dominated domestically by two carriers, FedEx Express and UPS, and given the fact that many "brand name" freight forwarders and passenger airlines with large market shares would be interviewed several times for each case study airport the team decided to reach out to headquarters of these nationwide air cargo businesses.

The second prong approach at the national level included contacting officials for UPS Properties division, FedEx Express Airport Relations, DHL Airport Affairs, third party cargo facility developers, passenger airlines such as Delta, Southwest and Alaska Airlines. Efforts were also made to large forwarders such as Hanjin, Forward Air and Swissport. The team determined that the most effective methodology, which UPS proposed and Southwest Airlines concurred with, was for corporate-level properties staff for the on airport companies to provide an initial contact between our team and their local cargo station managers at the 15 case study airports. While this was an extra step for team members it proved beneficial since local cooperation for UPS and Southwest airlines, for example, was considerably higher than for air cargo business than where approached at the local station level. Not all national firms were interested in participating in the study at the national or local level. FedEx Express chose not to participate due to internal work load issues within the Airport Relations division. FedEx was accommodating, however, by providing an interview with their systems engineering staff of which the findings are presented in a subsequent section of this report.

Although some surveys have yet to be completed as promised the research team was able to gather Air Cargo Business Surveys from each case study airport. Face-to-face interviews proved beneficial in getting responses from those tenants. Air cargo businesses that chose not to participate in the interviews often did not complete the survey. Several negative comments were received from participants regarding the length of the survey by respondents and non-respondents alike. Should additional survey efforts be determined in the Data Gap Analysis portion of this study, the overall survey length should be given an added level of scrutiny. Approximately 20 Air Cargo Business Surveys have been completed and returned; however, surveys continue to arrive and the data entered into the database.

Air Forwarders Survey – As the field work process took place the team realized a survey of air forwarders, both on and off airport would provide insight into this sector of the industry and their real estate and facility location decisions. A separate, brief two page Air Forwarders Survey was developed. In June, staff at the Kuehne & Nagle station at CVG tested/proofed the survey and provided comment. The survey asked questions regarding contact information, address, facility size, location (on or off airport) type of activity at the facility, traffic volume and location decision criteria. A copy of this survey and cover letter are presented in Appendix A.

Distribution of Air Forwarders Surveys – A three prong approach was used to distribute the surveys. The first was to send the surveys and cover letter to headquarters of air forwarder organizations. A list of leaders within the air forwarders industry was provided by the Air Forwarders Association. The survey was then sent to national headquarters of the 15 largest forwarding companies in the U.S. Only one, CEVA, responded and returned surveys for five of their stations. The others either did not respond to our request or declined to participate. The second approach was to contact forwarders at the local level. These surveys and cover letters were distributed to air forwarders at case study airports. We found it beneficial for airport staff to make introductions to the forwarding community or cargo associations. For example, Columbus Regional Airport Authority provided an introduction to the study/survey via email to their top 10 forwarders in their market. The research team sent surveys to these Columbus Ohio based on- and off-airport forwarders and received a 50% response rate. This was the best response rate for the forwarders survey of the case study airports. A third approach was also utilized to gather information from the air forwarders sector. In a separate effort, the team emailed the Air Forwarders Survey and cover letters to approximately 150 air forwarders in the Chicago market area. This email list was developed using the Quick Caller air cargo booklet as well as a tenant list from ORD. Unfortunately, there were no responses to this survey effort. There was not a second round of contacting these businesses.

Transportation Security Administration, U.S. Department of Agriculture and, Customs Border Patrol Interviews

The team made several efforts to include input from TSA, USDA, and CBP in the data collection effort. While regulators do not fit neatly into a survey format we thought it would be ideal to at least have a discussion with them at several airports. During these discussions it would be ideal to be able to ask the TSA (and possibly CBP) staff for their impressions of whether cargo security related inspections have had impacts on warehouse spatial needs. When we contacted these government agencies we attached a copy of the cover letter and Air Cargo Business Survey that we had been completing at each case study airport. Although several emails were exchanged with local stations and TSA cargo staff at DHS, and it appeared promising that we would have a meeting with these agencies, we were never able to arrive at convenient times for the meetings or the agencies declined to participate.

Survey Fatigue

Anecdotal evidence of airport planners and tenants points to "survey fatigue." One airport planner at a case study airport began our interview stating that "it is very difficult for airport planning and engineering departments to complete these types of surveys." Although many planning departments had interns or entry level personnel complete the survey it still takes considerable oversight from management and has to be fitted into their day-to-day operations and projects. Additionally, one cargo business indicated during an interview that they not only recently completed our ACRP survey, but also an Ohio Department of Transportation Freight Study survey as well as a survey for their airport's economic impact study. A person in their public relations division completed all three surveys as well as the interview.

SUMMARY

This technical report explains the ACRP 03-24 study data collection plan and implementation. The research team used a two-prong approach in the data collection task. First, the team used a case study approach focusing on select airports representing a range of airport types; second, a system wide data collection from airport management via a survey effort. This next chapter provides details on the data gaps analysis and tools and procedures used to fill those gaps. Highlights from the data collection plan and implementation are noted below.

- Survey tools were developed to gather information on the utilization and traffic flow related to on airport air cargo buildings. Two surveys were developed and included a survey of airport management and a second survey designed to gather information from private sector air cargo businesses.
- The Airport Planning Department Survey was developed by the research team to provide data on-airport cargo facilities, operations, and plans related to air cargo activity at case study airports as well as participating system airports.
- The Air Cargo Business Survey was developed by the team to provide data on cargo activity, on-airport cargo facilities, operations, and plans related to air cargo activity at case study airports as well as participating system airports.
- The goal of the case study airports is for team members to collect data from airport planners and management, interview key cargo related tenants regarding their facilities and operations and if appropriate meet with off airport cargo businesses such as air forwarders.
- Airport management for all 16 case study airports agreed to participate in the study and each was visited and interviewed by team members.
- The research team designed and implemented the Airport Planning Department Survey to collect air cargo data not only from case study airports but airports in the U.S. with scheduled air cargo service.
- Of the 55 system wide airports invited to participate in the ACRP 03-24 study by completing the Airport Planner Survey, 16, or 29%, chose to complete and return the survey. Five airports have yet to return their survey but have promised to do so. When combining the results of the 55 system wide airports with the results of the 16 case study airports, the response rate is a total of 31 completed Airport Planning Department Surveys representing a 44% response rate overall to the survey effort.

- A separate, brief two page Air Forwarders Survey was developed. This survey was sent to the headquarters of the 15 of the largest air forwarders in the U.S.; to local air forwarder stations at case study airports; and to a wide range of air forwarders in the Chicago market area.
- Anecdotal evidence of airport planners and tenants points to “survey fatigue.”

CHAPTER 6: TASK 4—DATA COLLECTION GAP ANALYSIS

CHAPTER OVERVIEW

Airport air cargo master planning revolves around two key aspects of air cargo activity: spatial needs for the movement and storage of air cargo vehicles (trucks, aircraft and GSE) and space for the storage of air cargo. Subtask 4 identifies data gaps commonly found in the airport master planning process. This tech memo describes the data gaps the project team experienced during the data collection phase of the project. The team also describes how data gaps related to specific surveys for this study were remedied through analysis tools provided by Google Earth Pro and other public documentation. This memo concludes with a discussion on efficient techniques to collect data on air cargo activity on airports.

INTRODUCTION

In 2012 the team conducted an intensive survey of air cargo facilities at U.S. airports. The data collected will be used to craft guidelines for air cargo facility planning and development at airports. The primary objective is to assist airport operators in utilizing effective planning practices and in making development decisions that meet the industry's current and future technological, operational, and security challenges in a cost-effective, efficient, and environmentally compatible manner.

GOALS AND OBJECTIVES

The purpose of Task 4 is to identify gaps in current data collection and reporting procedures, based on the output of Tasks 1 through 3, that affect air cargo facility planning and decision making. To assess what information is available and what is missing, and to develop cost-effective strategies to fill information gaps to improve the decision-making process. In addition, it will describe an approach to standardizing the form and content of the information required. Lastly, a technical memorandum reporting the results of this task for review and comment by the project panel will be prepared.

SUBTASK 4: CARGO VOLUME AND UTILIZATION DATA GAP ANALYSIS

The data collection effort for ACRP 03-24 utilized a combination of data gathering techniques which span from actual records, such as annual air cargo aircraft operations data from the control tower, (scientific or analytical evidence) to gathering anecdotal evidence to ascertain the use and utilization of air cargo facilities. The anecdotal evidence for this effort is comprised of airport management interviews and surveys, air cargo tenant interviews and surveys, as well as case studies and round table discussions to gather information on air cargo activities on airports. Although our team's data collection tools and techniques provided hundreds of data points, many of these were groupings of anecdotal information. Empirical evidence can come in large batches or small while one or a few data points make for anecdotal empirical evidence. Scientific or analytical evidence is not always readily available to the airport planner which, resultantly, requires innovation to fill in the data gap analysis.

Data gathered from airport management for this study included annual cargo tonnages, international cargo vs. domestic cargo volumes, and the number of air carriers operating at an airport as well as the amount of space assigned to these carriers. Data gaps are the result of the team's inability to ascertain scientific or analytical data. This lack of information is often the result of the private sector's (cargo carriers) unwillingness to share certain metrics related to their operations due to the proprietary nature of the data. While it would be possible to use the scientific method to make our own observations remotely outside the facility, i.e. 15 trucks approach and depart the UPS building at BWI per day, it is impossible to ascertain the volume in tons and number of pieces of cargo moving through the facility as well as determine to which cargo aircraft the cargo is assigned. In order to gain this information UPS would have to provide it or allow scientific observation and data collection within their facility which is highly unlikely. In short, the operators of air cargo activities on airports have the best data, or scientific evidence, of activities within these facilities. In fact many cargo carriers such as FedEx, UPS and third party providers rely on their own industrial engineers to determine the best operations model for moving cargo through their airport facilities. In addition, the staff at the local station on an airport often knows the best methods of utilizing their cargo facility since they are involved in the day-to-day operations and understand their facility's capabilities and short comings. It is important to point out that while UPS and some passenger carriers at case study airports allowed for interviews and completed several air cargo business surveys, the data was insufficient to build large data sets for targeted analysis. The most useful data set from the data collection effort is the result of the Airport Planners Survey.

The outcome then for ACRP 03-24 data collection efforts results in both anecdotal evidence of air cargo facility use and utilization; as well as empirical data on the facilities and cargo volumes accommodated by these facilities. The data collected is from a combination of data types and sources and represents the realities experienced by airport planners and airport planning consultants in their data collection efforts related to air cargo facility master planning. Data gaps experienced in these data collection efforts for this ACRP study, in surveys and interviews, is similar to air cargo data gaps commonly experienced during a typical airport master planning process.

SURVEY DATA COLLECTION RESULTS

Since this project focuses on air cargo facilities, specifically the development of new planning metrics in their design, survey tools were developed to gather information on the utilization and traffic flow related to on airport air cargo buildings. Three surveys were developed which included a survey of airport management and two surveys designed to gather information from private sector air cargo businesses. Given the sensitivities of a government sponsoring study gathering data from private sector business all surveys were carefully vetted to ensure no needlessly commercially intrusive questions were asked. The three primary survey tools developed for ACRP 03-24 include an Airport Planners Survey, an Air Cargo Business Survey and the Air Forwarders Survey. Subtask 3.1 discussed the survey tool design and implementation. The results of these surveys will be discussed here.

Airport Planning Department Survey **–** The *Airport Planning Department Survey* was developed by the research team to provide data for on-airport cargo facilities, operations, and plans related to air cargo activity at case study airports as well as participating system airports. Although the survey was titled *Airport Planning Department Survey,* the study team understood that airport planners, properties managers, marketing staff and airport air cargo managers were all potential respondents and so the survey instrument was designed with this wider respondent audience in mind. A detailed discussion of this survey and response rates to questions is forth coming.

Air Cargo Business Survey **–** This survey instrument was developed to provide data on cargo activity, on-airport cargo facilities, operations, and plans related to air cargo activity at case study airports as well as participating system airports. Most of the participating non-case study airports were asked to complete surveys after the case study airports data arrived and it was determined additional data was needed. The survey was designed to be completed by a wide range of cargo operators on an airport such as passenger airlines, integrated express (FedEx, UPS, DHL, etc.), cargo-only carrier/freighter, air freight forwarder, 3PL providers, regional air cargo carrier (Contractor) and ground handlers. The survey was sent or hand delivered to 174 air cargo business tenants via email and regular mail. Business lists were supplied by case study airports and non-case study airports. A response rate of 18% was achieved for this survey effort as a result of 31 responses being returned. While a higher response rate was hoped for the results may point to survey fatigue as well as relative importance in air cargo business day-to-day operations. The Air Cargo Business Survey was a self-completed survey that was emailed, mailed or handed out, completed by the respondent, then returned, either in person or by email. The key advantage of this approach is its relatively low cost, as one surveyor/interviewer can hand out a large number of questionnaires in a given time period. Disadvantages of this approach include lower response rates and inferior data quality. Length and complexity are also concerns; generally, airport planners should try to keep such surveys short and simple to maximize the number of responses and completeness of the information they get back. According to *ACRP Report 26: Guidebook for Conducting Airport User Surveys*, survey results for airports should be approximately 50%:

> Although experts differ on this point, a general rule of thumb is that the response rate needs to be at least 50% for a researcher to be reasonably confident that the results are representative. However, lack of response bias (difference in the mean value of the characteristics of interest between respondents and the population being surveyed) is more important than a high response rate (Babbie, 1973). Regardless of what is considered an acceptable response rate, the lower the response rate, the more caution must be used in interpreting the data. Response rates vary widely by survey method and are generally fairly high for interview surveys of air passengers, but much lower for surveys conducted by mail or telephone [of tenants].

Many of the responding businesses were for case study airports where facilities were visited by project team members and therefore had a personal interest in completing the survey. It is noteworthy to point out that 62% of the response rates were businesses located at international gateway airports with the remainder related largely to domestic cargo airports. Given the limited number of responses for this survey the usefulness of the data will be limited but will play a role in the facilities requirement task. Table 6-1 identifies the responses by type of cargo business.

Table 6-1 Air Cargo Business Survey, Responses by Type of Cargo Business.

	Responses	Rate
Integrated Express	9	29%
Passenger Belly	8	26%
Freighters	5	16%
Third Party Handler	8	26%
Regional Cargo Feeder	1	3%
Total	**31**	**100%**

SOURCE: CDM Smith

Air Forwarder Survey **–** This survey was developed to provide insight into this sector of the industry with particular emphasis on real estate and facility location decisions both on and off airport. The survey included questions regarding contact information, address, facility size, location (on or off airport) type of activity at the facility, traffic volume and location decision criteria. The survey was sent to the corporate headquarters for the top 15 air forwarders in the U.S. Only one of these businesses, CEVA, responded to our request and prepared responses for five CEVA locations. Surveys were also sent to air forwarding businesses listed on the airport planner's survey. An additional survey distribution effort took place with the emailing of surveys to 250 air forwarders in the Chicago market area. As a result of these distributions only eight additional surveys were returned for a total of 13 surveys, which represents a five percent response rate. Given the limited number of responses for this survey the usefulness of the data will be limited but will play a role in the facilities requirement task.

Airport Planning Department Survey Results

The Airport Planning Department Survey was distributed via e mail to the 16 case study airports who had agreed to participate. A response time of 10 days was requested for completion. Many airport planners assigned to complete the survey indicated they would need three to four weeks to complete the survey due to work load issues. A list of 55 system wide airports was developed, in addition to the 15 case study airports, and each was contacted to request their participation in the ACRP 03-24 study by completing the *Airport Planning Department Survey*. This invitation consisted of an email introduction to the study, a pdf cover letter for the survey and the survey in pdf form. As indicated in a previous section of this report, the response rate with case study airport was 100% but only 29% or 16 among the system wide outreach.

The Airport Planners Survey collected data on the following airside and landside components: storage facilities, warehouse and office space; processing space; specialized services (including refrigeration and climate-controlled facilities); sorting equipment; parking spaces (aircraft and truck) and gates; fueling, deicing, and other servicing facilities; ramps and docks; off-airport facilities; gate access and egress components; security and customs clearance facilities; and others, as appropriate.

Survey Sample: Size & Distribution

As listed in Table 6-1, a total of 31 airports responded with 16 being the case study airports. The research team designed and implemented the Airport Planning Department Survey to collect air cargo data not only from case study airports but airports in the U.S. with scheduled air cargo service. This survey effort was system wide gathering data from ACI member airports which represent a wide range of airports in size and characteristics such as international gateway and major hub airports as well as O&D airports. The system wide airport distribution list was developed by a review and analysis of air cargo facility data collected by an ACI-NA airport facilities project (ACI-NA, 2004). This ACRP 03-24 study is designed to update cargo facility data previously gathered during a 2002-2003 survey effort. The previous list was expanded to include airports in a variety of geographic locations. The list of airports currently included in the distribution is highlighted in Table 6-2. Of the 55 system wide (non-case study) airports invited to participate in the ACRP 03-24 study by completing the Airport Planning Department Survey, 16, or 29%, chose to complete and return the survey. The airports represent a broad cross-section of cargo volumes. Four of the top ten North American airports (ranked by 2011 total cargo volumes) and nine of the top 20 responded. While the inclusion of these top cargo airports assures that the survey sample represents the majority of air cargo in the U.S., the strong sample distribution also includes an excellent sample of medium and small airports as well.

Table 6-2 Air Cargo Case Study and Non-Case Study Airports.

Airport	Market	2011 Metric Tons
Case Study Airports		
International Gateways		
Atlanta Hartsfield-Jackson Int'l (ATL)	Atlanta	663,162
Dallas Fort Worth Int'l (DFW)	Dallas	654,415
Seattle-Tacoma Intl (SEA)	Seattle	279,625
Alternative International		
Rickenbacker Intl (LCK)	Columbus	66,287
King County/Boeing Field (BFI)	Seattle	115,000
Indianapolis Intl (IND)	Indianapolis	971,664
Passenger Hub		
Washington Dulles Intl (IAD)	Washington DC	302,661
General Mitchell (MKE)	Milwaukee	76,627
Denver Intl (DEN)	Denver	248,141
Air Cargo Hub		
Spokane Intl (GEG)	Spokane	49,096
Des Moines Intl (DSM)	Des Moines	61,584
Cincinnati/Northern Kentucky Intl (CVG)	Cincinnati	481,669
O&D Airport		
Austin Bergstrom Intl (AUS)	Austin	69,556
San Antonio Intl (SAT)	San Antonio	121,516
Louis Armstrong-New Orleans Intl (MSY)	New Orleans	48,464
Kansas City Intl (MCI)	Kansas City	85,998
Non-Case Study Airports Completing Airport Planners Survey		
Albuquerque International (ABQ)	Albuquerque	55,063

Table 6-2 (*continued*) Air Cargo Case Study and Non-Case Study Airports.

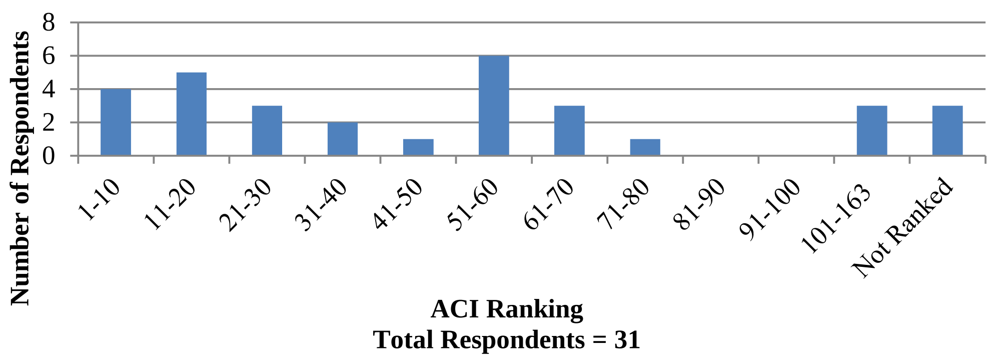
Airport	Market	2011 Metric Tons
Baltimore/Washington Int'l Airport (BWI)	Baltimore/Washington	107,741
Fairbanks International Airport (FAI)	Fairbanks	19,877
Greenville-Spartanburg International (GSP)	Greenville-Spartanburg	25,279
Jackson-Evers International (JAN)	Jackson	6,089
Jacksonville International Airport (JAX)	Jacksonville	65,914
Louisville Regional Airport Authority (SDF)	Louisville	2,188,422
Metropolitan Oakland International (OAK)	Oakland	483,375
Nashville International Airport (BNA)	Nashville	40,817
Philadelphia International Airport (PHL)	Philadelphia	415,205
Phoenix Sky Harbor International (PHX)	Phoenix	274,046
Southwest Florida International Airport (RSW)	Fort Myers	14,764
St Louis Lambert International Airport (STL)	St Louis	69,576
Ted Stevens Anchorage Int'l Airport (ANC)	Anchorage	2,543,105
Theodore Francis Green State Airport (PVD)	Providence	10,368

SOURCE: Airports Council International (ACI-NA)

Figure 6-1 shows the size distribution of airports represented in this survey. Given the size definitions below (established by ACI-NA's 2002 Air Cargo Facility & Security Survey), the sample consisted of five Large Cargo Centers; nine Medium Cargo Centers; and 17 Small Cargo Centers. For example, four of the top 10 cargo airports that participated in the study and include: Ted Stevens Anchorage International, Sandiford-Louisville International, Indianapolis International, and Hartsfield-Jackson Atlanta International.

- Large cargo centers – 500,000 or more metric tons in 2011.
- Medium cargo center – 100,000-499,999 metric tons in 2011.
- Small cargo centers – 100,000 or less metric tons in 2011.

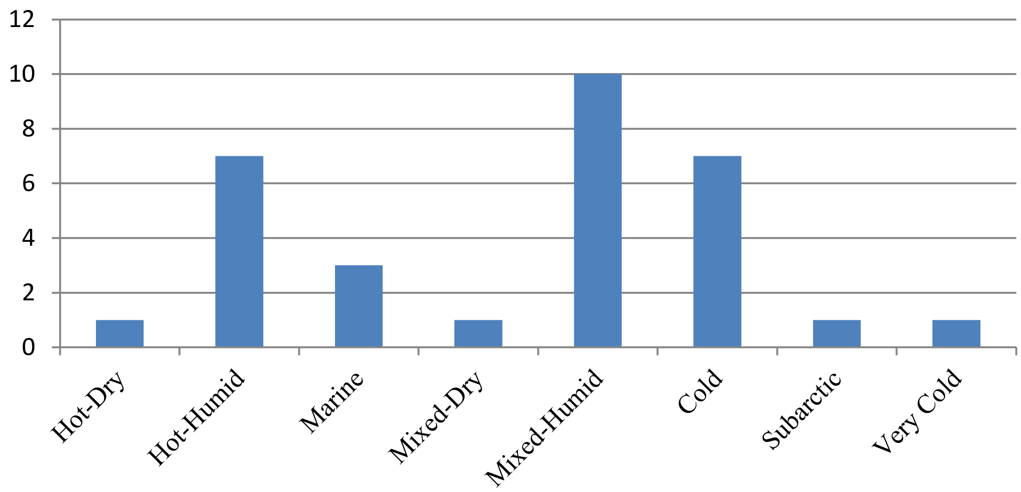
Figure 6-1 Number of Respondents by ACI Cargo Ranking. (SOURCE: ACI-NA, 2010.)



In addition to covering a wide range of air cargo airport roles and service levels, the research team added information related to the climate in which each airport is located. Our sample of case study airports and non-case study airports represents a diverse range of locations and operating environments.

This information was added since it became apparent during the data collection that air cargo operations in milder climates tend to operate with less warehouse space and more in the open on the airport ramp. The 31 respondent airports are located in eight different climate zones as defined by U.S. Department of Energy. As shown in Figure 6-2, the majority are located in the Mixed-Humid climactic region, which is one of the larger climate zones of the contiguous 48 states, stretching from Kansas to North Carolina and from Pennsylvania to Georgia.

Figure 6-2 Number of Respondents by Climate Type. (SOURCE: U.S. Department of Energy.)



Survey Question Composition

The survey has three main parts, each with multiple subject areas. Part I consists of general airport information including contact info, air cargo activity (carrier composition, domestic and international traffic), cargo buildings/areas, air cargo facility plans, and environmental factors. Part II focuses on the details of the cargo buildings, which includes general facility dimensions and access, and special characteristics such as refrigeration and perishables storage. Part II also collects data on cargo building occupants and their particular operational characteristics. Part III asks respondents to provide a contact list for all air cargo tenants. The research team was able to fill in data gaps related to airport cargo buildings by utilizing several data sources such as Google Earth Pro, and county auditor records. Our team also used third party developer data for cargo building specs posted online. The survey concluded with respondent's perceptions and critique of the survey tool as well as an estimate of the time taken to complete the survey.

AIRPORT PLANNING DEPARTMENT SURVEY PART I—GENERAL AIR CARGO ACTIVITY AND FACILITIES

General Airport Information **–** The first section of the survey addresses general airport information such as airport name, three-letter identifier, contact person, title, department, and email address. This section achieved a 96% response rate, with only a small number of airports neglecting to provide contact information.

Air Cargo Activity **–** This section addresses three main areas of air cargo activity: carrier composition, annual tonnage, and domestic/international traffic. Overall, this section had a response rate of 64%. These sub-topics are further discussed below:

- *Carrier Composition* **–** This sub-section addresses the number of airlines operating at each airport and asked for each airline by name and type (i.e. passenger, integrated express cargo, and all-cargo carriers). As a whole, this sub-section saw an average response rate of 81%.
- *Annual Tonnage* **–** This sub-section requests annual tonnages from each airport, both inbound and outbound, for 2011. This sub-section returned an average response rate of 86%.
- *Domestic and International Traffic* **–** This sub-section attempts to break down the tonnages reported in the previous section by the following levels: Domestic or International > Enplaned or Deplaned > Type of Aircraft (passenger or all-cargo) > Freight or Mail. This sub-section had an overall response rate of 55% (66% for domestic; 43% for international). Not all airports collect domestic vs. international cargo splits data.

Cargo Buildings and Areas **–** This section identifies the number of buildings and areas within each airport that are dedicated to air cargo activity. Management structure, shared usage, and largest cargo aircraft accommodated are also identified by respondents. This section had an average response rate of 63%.

Air Cargo Facility Plans **–** This section explores each airport's expansion/improvement plans of their listed air cargo facilities, if applicable. Motivation for improvement, type of improvement, developer, estimated completion date, dimensions, anticipated occupants/primary users, and special characteristics are discussed here. This section experienced an average response rate of 17% and may be indicative of a lack of cargo facility planning at airports.

Environmental Factors **–** This section gauges the interest the air cargo industry has in reducing their environmental footprint and any efforts taken to achieve those goals. Early on in the study process environmental issues/enhancement were thought to be of high priority to the air cargo industry, the response has determined that sustainable enhancements are a much lower priority than expected. Only three of the 31 respondents reported any LEED certified air cargo facilities. Age of the air cargo facilities may play a role in this response rate since airport management may not pursue environmental related improvements to older structures. However, 10 respondents reported a total of 22 other energy efficiency upgrades to their air cargo facilities. These upgrades include installing skylights, warehouse windows, white/reflecting roof, green roof, CFL/LED lighting, solar panels, and improved insulation. This section returned an average response rate of 28%.

AIRPORT PLANNING DEPARTMENT SURVEY PART II—CARGO BUILDINGS DETAIL

Cargo Buildings **–** This section discusses the general details of each cargo building on each airport. Building name, total area in square feet, ownership, access, ramp size, ground service equipment (GSE), truck parking, truck docks/doors, security protocols, surplus space, and number of tenants are all data items asked of each respondent. At total of 118 air cargo buildings were listed by respondents, and—through various other sources—the team was able to bring this total to 170. All questions within this section had an average response rate of 68%.

Facility Special Characteristics **–** This section explores the frequency at which cargo facilities have unique features such as perishables storage, unit load device (ULD) handling, roller/castor floors, sorting systems, material handling systems (MHS), elevating traversing vehicles (ETV), telecommunications systems, security screening, and green design. The respondents indicated that only 21% of the 177 air cargo buildings had at least one special handling characteristic. This indicates that the large majority of air cargo facilities surveyed do not have special characteristics. Only the most heavily used air cargo facilities have the demand to warrant unique cargo handling features. In order to limit a carrier's capital expenditures and operating costs, freight requiring special handling will be shipped through a cargo facility at an airport with the appropriate handling capabilities. The overall response rate for this section was 10%.

Cargo Building Occupants – This section requests each airport to identify all occupants within in their listed air cargo buildings and details for each occupant. A total of 406 occupants were reported by respondents, which included 22 vacancies. Through field visits and examination of online airport records, the consultant team was able to identify an additional 30 occupants, bringing the total number of occupants to 436 (again, including 22 vacancies). Details for each occupant were also requested, which includes occupant name, air cargo category, unit number, total area, warehouse area, office area, GSE area, ramp area, operations per day, peak-hour aircraft parking, aircraft fleet mix, handling, and number of carriers. The average response rate for these questions was 57%.

AIRPORT PLANNING DEPARTMENT SURVEY PART III

Air Cargo Business List

The third and final section of the survey asks respondents to provide a contact list for all air cargo tenants. Out of the 31 survey participants, 14 (45%) airports provided a contact list for a total of 174 tenant contacts (40%). All 174 contact entries provided a name, address, and phone number. Email addresses were provided for 137 (74%) of the tenant contacts, which represents 31% of all occupants listed by respondents. The average response rate for this part of the survey was 66%.

The average response rates for each section and sub-section of Parts I, II, and III of the survey are summarized in Table 6-3. Tables listing the response rates by individual survey question are available in Appendix B. A copy of the actual survey is available in Appendix A.

Within the response rate tables of Appendix B, there are several response classifications that require explanation. These include the following: *Hard Responses*, *CDM Smith Estimate*, *N/A*, *N/A (CDM Smith Estimate)*, *Incomplete*, and *Usable Data*. *Hard Responses* are from respondents and include only usable information; incomplete data is excluded. Through field visits and various other online sources, CDM Smith was able to enhance fill in data gaps with estimates/assumptions. This data is classified as *CDM Smith Estimates*. All data that was "N/A" or not applicable was accounted for and excluded from respondent answers since it is not useful information. In several instances the research team estimated or made assumptions on data that was also "N/A" or not applicable. This data was also accounted for and excluded. *Incomplete* data includes any blanks, question marks, and other unknown or null answers that are not usable. *Usable Data* is the result of combining *Hard Responses* and *CDM Smith Estimates* while excluding all unusable data.

Table 6-3 Summary of Average Survey Response Rates.

PART I	Respondents	-	62%
	General Airport Information	-	96%
	Air Cargo Activity	1.1 – 1.5	64%
	Cargo Buildings and Areas	1.6 – 1.13	63%
	Air Cargo Facility Plans	1.14 – 1.25	17%
	Environmental Factors	1.26 – 1.28	28%
PART II	Total Cargo Buildings	-	177
	Cargo Buildings Detail	2.1 – 2.13	47%
	Facility Special Characteristics	2.14	9%
	Cargo Building Occupants	2.15	44%
PART III	Airports Providing Contact List	3.1	45%
	Tenant Contacts Provided (% of all tenants)		40%
	Tenant Email Addresses Provided (% of contacts provided)		79%

SOURCE: CDM Smith

Survey Assessment/Feedback

At the conclusion of the survey, respondents were asked to provide the time required to complete the survey and give their opinion on survey length. Forty-three percent of respondents participated in the survey assessment, and the average survey completion time was 286 minutes or 4.75 hours. The majority of participants felt that the survey was too long and too detailed; while some thought it was adequate. Almost none of the participants felt that the survey was too short or not detailed enough. These results are summarized in Table 6-4 below.

Table 6-4 Survey Assessment/Feedback.

Part	Question	Response Rate
SURVEY FEEDBACK	Feedback Participation	43%
	Average Completion Time (hours)	4.75
	Too Long	29%
	Too Short	0%
	Just Right	18%
	Too Detailed	25%
	Not Detailed Enough	4%
	Just Right	14%

SOURCE: CDM Smith

DATA GAPS ANALYSIS

The research team has years of experience collecting data from the air cargo community which is a highly competitive sector and often reluctant to reveal information related to operations, volume, commodities, and customer base. While data gaps are always inevitable we have found surveying with follow-up interviews, as described in Task 3, as one of the best means to collect information vital to the study to minimize gaps in the data collection. The face-to-face meetings often put respondents at ease, help answer any questions upfront, and help legitimize the study in their mind. But often there are data points that are missed, lack sufficient amounts, or have yet to be considered in air cargo facility analysis.

Task 4 requires the identification of gaps in data collection and reporting procedures, based on the output of Tasks 1 through 3, that affect air cargo facility planning and decision making. In this task, available information will be reconciled against what is missing, and cost-effective strategies will be developed to fill information gaps to improve the decision-making process.

Techniques to Backfill Missing Airport Planner Survey Data

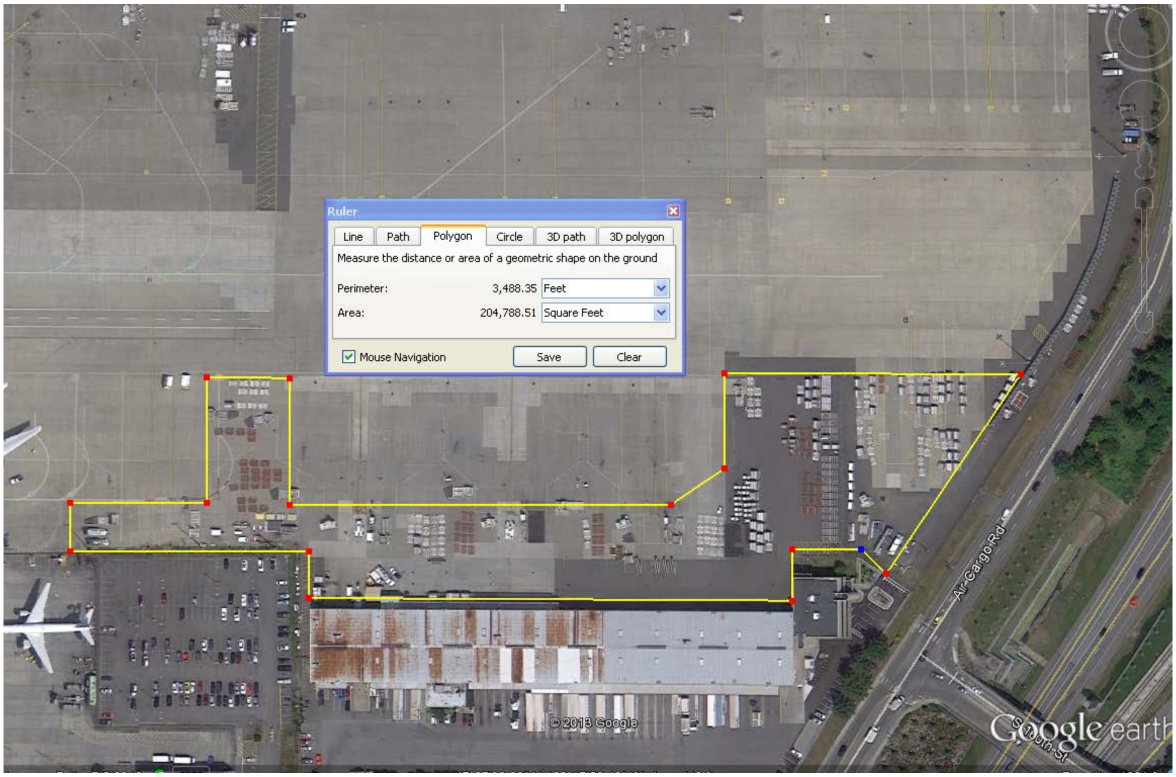
As indicated in the previous section, the team was able to fill in many data gaps related to the Airport Planners Survey with measures based on field visits as well as various online sources such as Google Earth Pro, Bing Maps and government records. These steps provide relatively inexpensive data collection practices and were particularly helpful in filling in missing information on building size, occupant space in square feet and identifying space used by air cargo businesses for truck parking, truck docks and truck door counts, gate access, aircraft ramp space and GSE storage. This section of the report will present methods and tools for collecting data for air cargo facility space and uses where gaps exist.

It is advised that airport planners with aerial photo interpretation skills conduct an analysis of air cargo facilities. Based on the research team’s experience in airline and air cargo operations as well as skills in air photo interpretation we were able to determine several patterns in activities on the ground related to air cargo operations by type of carrier and building occupant. We call this pattern of activity “freightcraft” which is a play on the term “tradecraft” which used in the intelligence community for analysis of foreign military operations, facilities and equipment. Freightcraft is the gathering of information related to air cargo activities on the ground. Information and land use patterns can be ascertained through aerial images regarding: aircraft ramp space, GSE space, warehouse space, truck parking, loading docks and loading doors. Information may also be ascertained for cargo roadway access, aircraft taxiway and taxi lane access, and security gates.

One of the primary tools for gathering information on space utilized for air cargo activity on an airport is the analysis of aerial and satellite images using Google Earth Pro or Bing Maps. Google Earth Pro allows the user to measure areas via a polygon measuring tool. This tool provides options for measuring area in square footage, square yards, acres, meters, etc. and can be applied to air cargo warehouses, GSE area, aircraft parking ramp, as well as truck parking. Google Earth Pro also has options for viewing buildings and structures from a “street view” perspective as well as a 3-D building option but not all buildings have the 3-D data input into Google Earth. Bing Maps provides aerial views of airports and has an oblique or “birds eye” view which allows for views of the sides of buildings. Airport Layout plans (ALPs) are also useful tools for airport planners to gather data on facilities but the advantage of aerial photos is that aircraft types can be depicted, as well as the types of ground handling equipment in the GSE area.

Ground Service Equipment Storage – GSE locations are typically adjacent to air cargo warehouses and often placed on pavement related to the aircraft parking ramp. GSE storage also commonly follows security fence lines and consists of a mix of equipment. GSE typically includes ULDs, dolly trailers for towing ULDs, portable air stairs, tugs, belt loaders, and K loaders for loading cargo into aircraft main decks. Equipment may also include APUs, forklifts, slave pallets, and aircraft maintenance vehicles. Deicing equipment may be stored in GSE areas during the winter months. GSE areas may be divided by a tug lane which is marked on the pavement. Aircraft taxi lanes may also be adjacent to the GSE area and should not be included in the size analysis. Figure 6-3 below is an example GSE space analysis in Google Earth Pro for the FedEx Express facility at Seattle International Airport (SEA). The yellow polygon identifies the assumed boundary for the GSE space and the total square footage arrives at just over 200,000 ft^2 of space being utilized for GSE. It is noteworthy to point out the hard stand area in the far right (light colored pavement) is a hard stand for ATR-73 aircraft but it is currently being used for GSE storage. GSE areas adjacent to passenger belly cargo warehouses typically do not include space for aircraft ramp since air cargo is tugged to the passenger ramp area near the terminal.

Figure 6-3 GSE Area Estimate for FedEx Express at Seattle-Tacoma Intl. Airport. (SOURCE: Google Earth Pro, CDM Smith Analysis.)



Aircraft Parking Ramp – Aircraft parking areas can be ascertained by noting where aircraft are parked in an aerial photograph but often cargo aircraft are not present when the image was taken. Airports typically mark aircraft hard stands by painting parking positions, and other important demarcations, on the pavement. Figure 6-4 illustrates the typical parking position markings for the FedEx Express hard stand (ramp) at SEA. The yellow taxi line is at the center of the position with the equipment foul line marked in white, which forms the shape of an aircraft profile. Figure 6-5 below is an example aircraft ramp space analysis in Google Earth Pro for the FedEx Express facility at SEA. The yellow polygon identifies the assumed boundary for the aircraft parking space. The total square footage arrives at nearly 180,000 ft^2 of space.

Air Cargo Warehouse – A number of tools are available to the airport planner for determining the space associated with air cargo warehouse space when it is not available from lease/ sublease documents and tenants are nonresponsive to requests. A cargo building with a single tenant occupying 100% of the space is fairly easy to assess. Utilizing Google Earth Pro the cargo building perimeter can be outlined. Care should be taken to not include office space as warehouse space. Office space may be located in a wing of the building or it may be "carved out" of warehouse space. Carved out office space can usually be obtained through the building landlord or by requesting the information from the tenant. Typically office space in a warehouse that has adjacent aircraft parking is kept to a minimum to optimize the use of the warehouse floor. Office space may also be located on a mezzanine level within the building.

Figure 6-4 Example Cargo Aircraft Parking Position – FedEx Express at Seattle-Tacoma Intl. Airport. (SOURCE: Google Earth Pro, CDM Smith Analysis.)

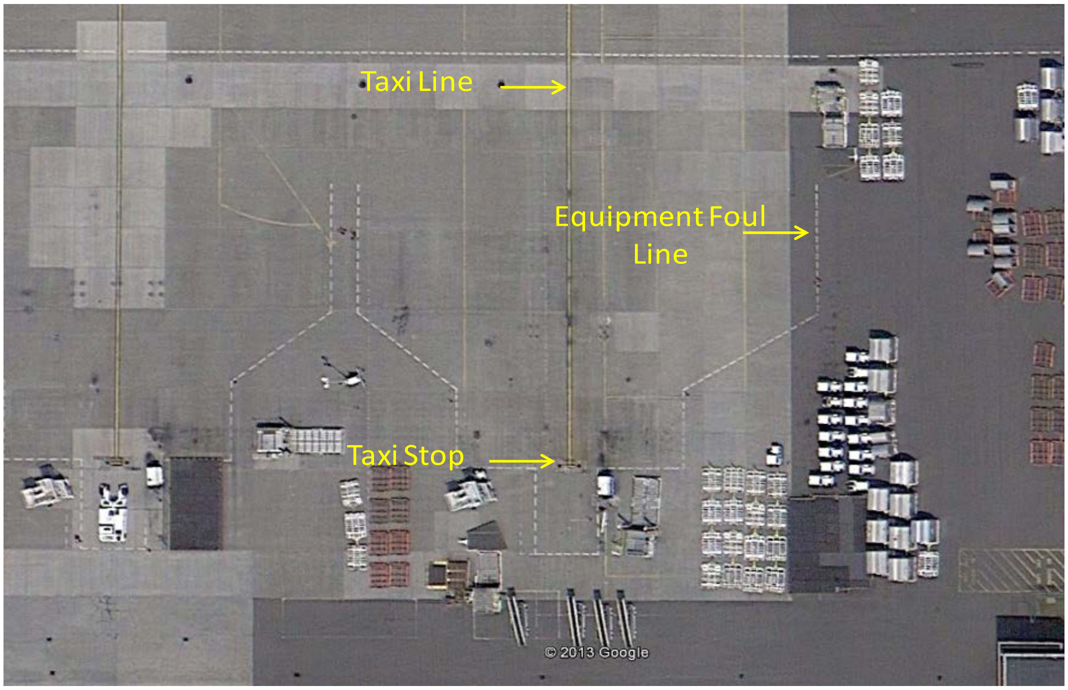
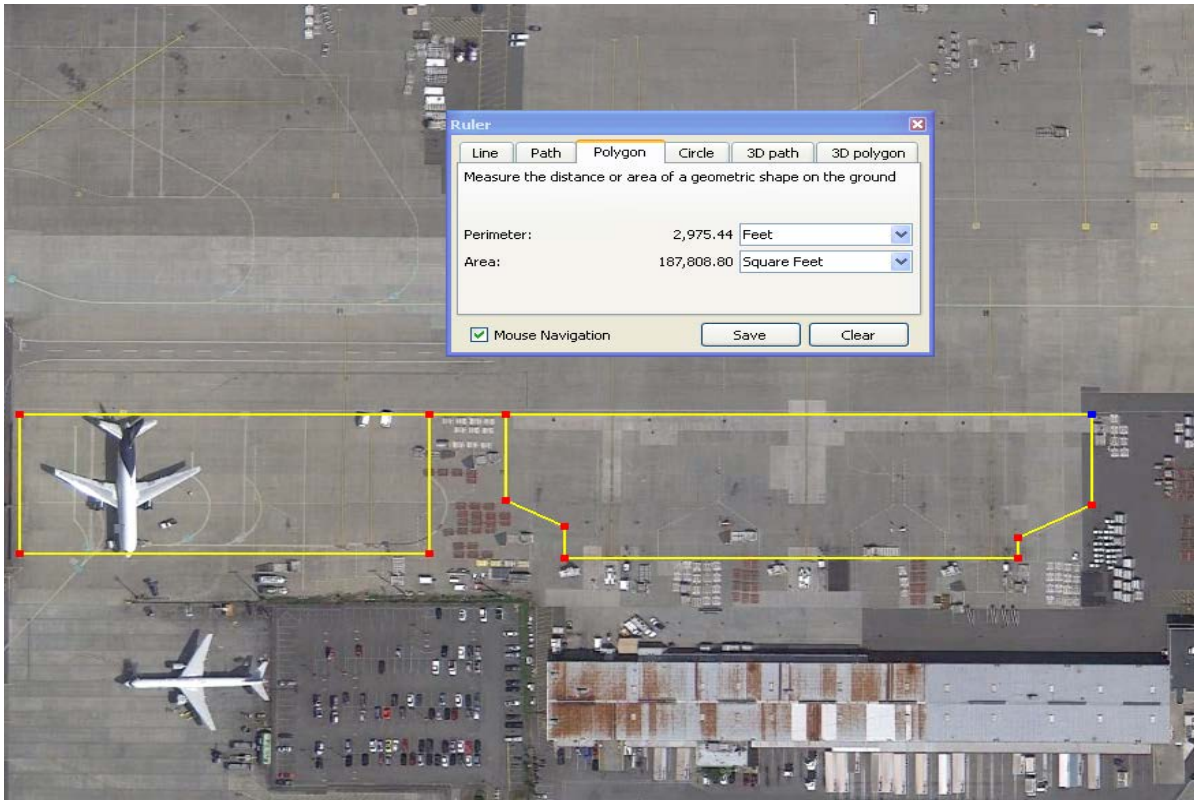
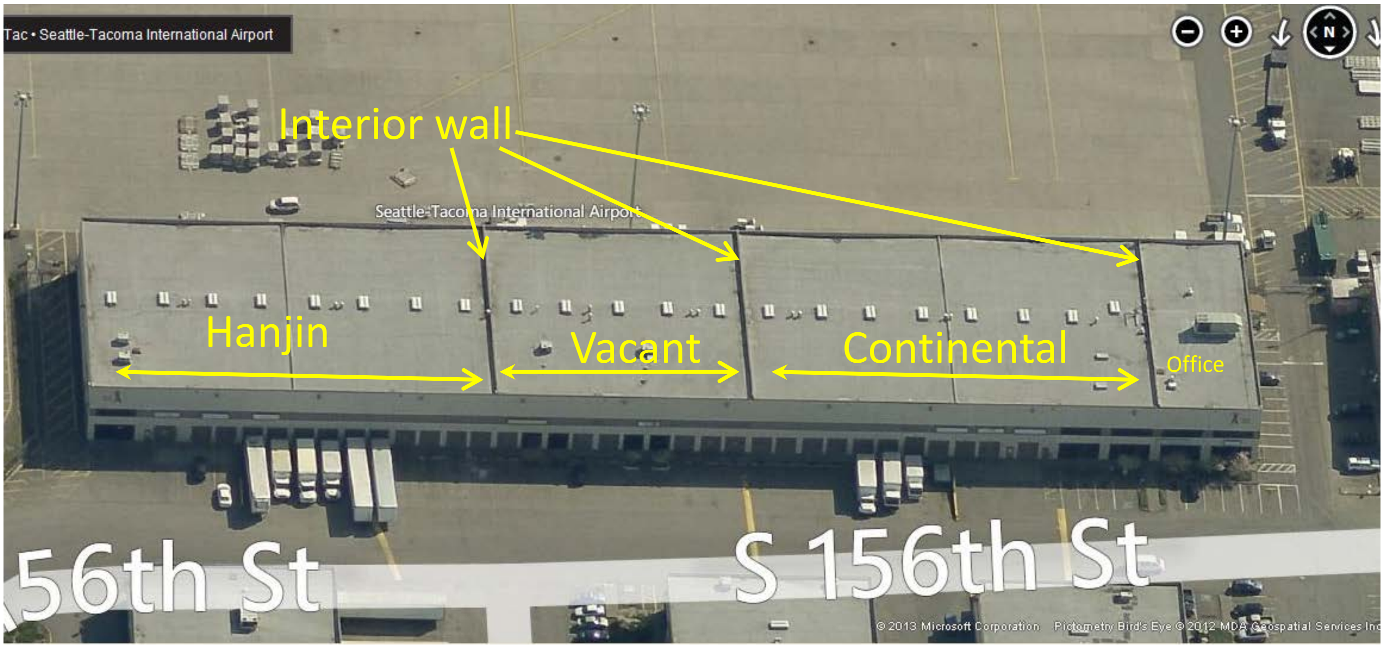


Figure 6-5 Aircraft Parking Area Estimate for FedEx Express at Seattle-Tacoma Intl. Airport. (SOURCE: Google Earth Pro, CDM Smith Analysis.)



One of the more challenging aspects to remotely assessing the space of a warehouse is determining the amount of space assigned to each occupant. In the case of Building B at SEA, square footage was ascertained through a combination of air photos (Bing Maps) and tenant surveys. As illustrated in Figure 6-6, on the eastern side of the building Hanjin provided their square footage for their office and warehouse space. The remainder of the building was unknown, and for illustration purposes the top of the photo is oriented to the south. Air photo analysis in Google Earth and Bing Maps and assessment of the remaining facility from the exterior during the field work portion of the study assisted in estimating the remaining warehouse space when it is not available from lease/sublease documents and tenants are nonresponsive to requests.

Figure 6-6 Example Estimating Technique for Building B at Seattle-Tacoma Intl. Airport. (SOURCE: Google Earth Pro, CDM Smith Analysis.)



Warehouse occupant space information may also be obtained, as a last resort, through local building permits and county auditor/assessor web sites. For example, for the UPS cargo Building at St Louis International Airport the St. Louis County Revenue Division has information on the building size, lot acreage, year built, lists of improvements, and heating systems, among other criteria. Nearly each county in the U.S. has similar property data bases with some being more robust than others. An additional source for cargo building occupancy and space breakouts are third party developers which lease these buildings to the air cargo industry. Appendix A provides an example air cargo building profile for an Aeroterm Building located at Southwest Florida Regional Airport (RSW).

Google Earth Pro also supports 3D modeling capabilities and some airports are utilizing this function. 3D models help airport planners visualize the relationship new buildings will have with existing facilities. Figure 6-7 illustrates the 3D capabilities for an airport by plotting the location of the UPS facility.

Figure 6-7 Google Earth Pro 3D – UPS 3D Rendering at St. Louis Intl. Airport. (SOURCE: Google Earth Pro.)

Air Cargo Warehouse Truck Docks and Doors **–** Air cargo warehouse throughput is often related to the number of available truck docks and truck doors to service the trucking side of the industry. Airport planners can obtain the number of warehouse truck docks and doors by utilizing Bing Maps Birds Eye View function as exhibited in Figure 6-8. By rotating and viewing all sides of the facility the number of doors and docks can be ascertained. Google Earth Pro Street View is also a useful tool since it provides a direct side view of the facility (Figure 6-9)**.**

Air Cargo Warehouse Truck Parking **–** Truck parking capacity is needed in the air cargo master planning process. Truck parking includes stalls adjacent to the cargo building at either truck docks or doors as well as stalls in the building's parking lot. Both Google Earth Pro and Bing Maps are useful tools in ascertaining the number of truck parking positions as well as total area.

Figure 6-8 Google Earth Pro Street View – Cargo Building B at Baltimore-Washington Intl. Airport. (SOURCE: Google Earth Pro.)

Data Collection Challenges

When comparing airport passenger terminal master planning process to that of the air cargo terminal or warehouse master plan process, the passenger terminal planning process has far more data available to the airport planner. Airports often have better data on passenger terminals since they have command and control of the terminal throughput information. Airports collect information on passenger movements through the curbside, ticketing, security and gate hold rooms. Airports also collect data on passenger expenditures in concessions as well as baggage claim information among many others places where passengers and airport businesses intermix. The challenge for the airport planner then is the lack of data on air cargo movement and throughput within air cargo buildings and support infrastructure. Airport management for decades has provided space for air cargo carriers and other cargo related business without a thorough understanding of the methods and practices of cargo carriers. In the U.S. there is in fact a veil of obscurity between the air cargo industry and airport management. Airport planners understand the general movements of cargo through the landside and airside cargo infrastructure but the carriers and the third party handler businesses have the best grasp of the cargo activities on airports. Even third party facility providers lack detailed information on cargo building throughput since their air cargo related tenants internally perform facility strategies and plans. The carrier may choose to move cargo primarily via fork lift and pallets, or they may choose a slide-sortation system since they will move primarily small packages. Large cargo facilities at international gateways may rely heavily on roller floors for ease of ULD movement. These design and planning decisions are often made at the corporate level by the carrier's industrial engineers.

The airport planner who has been given the air cargo planning task may also find that the level of interest for air cargo master planning at the low end of the priority list in airport's Master Planning process. Resultantly the planner may lack adequate funds to perform a thorough cargo data collection effort since, for example, the passenger terminal planning was given higher priority. The planner then must make wise choices in the best methods of collecting information on cargo activity without burning through the planning budget.

Air cargo master planning revolves around two key aspects of air cargo activity: spatial needs for the movement and storage of air cargo vehicles (trucks, aircraft and GSE) and space for the "storage" of air cargo. (Storage of cargo may last from several days to mere minutes). This section identifies sources of air cargo data that will assist the airport planner in developing an inventory of facilities and traffic volumes. While a survey of cargo businesses is often the best method of collecting data it is important that the airport planner collect data from in-house data whenever possible as well as develop a continuous data collection effort for a wide variety of cargo activities. Additionally, the air cargo industry in many of the larger cargo markets have air cargo associations which include both carriers and air forwarders. These organizations may assist in data collection efforts and airport management benefits by supporting these groups.

Cargo Volume – Cargo volume, or traffic, at airports is typically collected by airport management in their operations division, planning division, air service development division or business planning division. Types of cargo volume data collected usually include air cargo (freight and mail) weight in tons or pounds (monthly and annually). Usually one or two people in airport management are required to collect the data from the air carriers and enter the data into a database. This data is typically prepared to be presented in report or spreadsheet format. It is noteworthy to point out that some airports gather cargo data as landed weight by carrier which includes both the aircraft weight and the aircraft weight. While this type of data collection follows an FAA method of gathering data on cargo it is an incomplete data source and is difficult to use in cargo facility analysis.

Some airports will track and provide air cargo weight statistics by carrier market share. This data is very beneficial to the airport planner since it provides information on how much cargo each carrier is moving through their assigned areas on the airport. Air traffic control towers also have air cargo carrier operations data by type of aircraft (passenger or cargo, etc.) and by carrier name as well as aircraft design type. Air traffic control tower data is also useful for determining peak hours of cargo operations. As mentioned in Task 5 Forecasting Cargo, air cargo traffic arrivals and departures data may also be obtained relatively inexpensively through Official Airline Guide (OAG) schedules, FAA IFR data, as well as Flightaware.com data.

Air cargo volume arriving and departing the airport cargo facilities on trucks is difficult to obtain. This data would only be known the truck operator or carrier. A survey of carriers may provide information on truck volumes but it is again proprietary information and may not be easily obtained. Air forwarders that are located off airport often will not provide this information if requested by airport management.

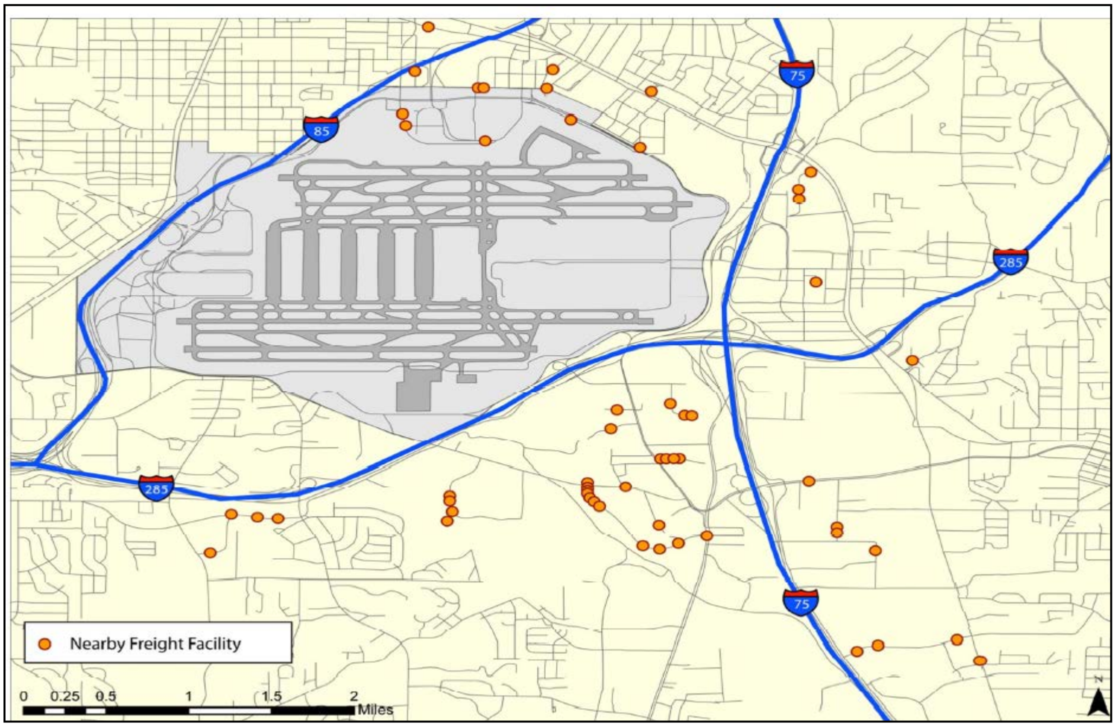
Air cargo volume by pieces per hour is also difficult to obtain by airport planners. This information is often considered proprietary by cargo carriers and is greatly affected by the level of package sortation automation within a cargo building. Some carriers provide this information in press releases when new cargo facilities are opened. For example, FedEx Express indicated in a press release that their Memphis hub accommodates 325,000 documents (Overnight Letters, Courier Paks) per hour while the Oakland FedEx facility can accommodate 12,000 packages per hour. Piece per hour information is not critical to the airport planner but can be useful when comparing facility efficiency.

Cargo Operations – Cargo operations take place in three primary areas on an airport. On the landside truck operations take place at Building/warehouse loading docks and parking lots. Operations also take place at the cargo building where cargo is handled and stored as well as sorted in the case of integrated express carriers. Cargo operations take place as well on the aircraft ramp or apron area and where aircraft and GSE vehicle operations intermingle. And, of course, cargo aircraft also utilize the taxiways and runway systems but our discussion here is limited to the immediate areas concerning areas on an airport designated for air cargo activity.

Cargo Security Operations – Collecting data on warehouse space designated for security is challenging to obtain since air cargo operators are reluctant to discuss or provide this information due to the sensitive nature of the topic. Also, the utilization rate for security equipment ranges greatly. During our field visits we observed on passenger carrier with a work bench size platform for keeping "trace" detector equipment. At another cargo warehouse for passenger carrier "hub" operations the carrier had three scanner detection systems with two for scanning packages and one for scanning oversized cargo positioned on wooden pallets.

Air Forwarders – Air forwarders are often located at off-airport locations which make gathering data for these facilities extremely difficult as well. During the team's field work efforts we were able to interview several off-airport forwarders but these meetings were essentially set up at the behest of airport management. Air forwarders are located on an airport when they need a direct advantage of access to aircraft. Since lease rates are almost always lower at off-airport warehouses in the vicinity of an airport air forwarders often chose to locate at these facilities. Figure 6-9 below identifies air forwarder locations in the vicinity of Hartsfield-Jackson Atlanta International Airport.

Figure 6-9 Freight Forwarder Location Map Hartsfield-Jackson Atlanta Intl. Airport. (SOURCE: Atlanta Regional Freight Mobility Plan 2008.)



Truck Parking/Movements – Truck movements on the landside area of the airport include truck trips on airport access roads as well as truck parking in designated lots in the air cargo area. These lots may be adjacent to air cargo buildings or in separate designated truck parking lots. Data for truck parking can be collected by airport planners by conducting an air cargo truck parking survey. This would entail collecting truck parking data through observation as well as truck driver surveys. Survey questions would request information related to arrival time, departure time, parking duration (waiting time), truck type and size, commodities carried and origin/destination data. Other data that could be collected includes frequency of trips to the airport cargo area on a weekly or monthly basis. Surveys would need to be conducted at various predetermined times throughout the week. Other tools used to collect truck operations and fleet mix data include traffic counters as well as web or security cams.

In 2011, the Federal Motor Carrier Safety Administration concluded a study utilizing web cams to evaluate a technology capable of collecting data to determine whether a truck parking area is full, and if not full, to indicate the number of spaces available. The program utilized The SmartPark video system which has software that automatically counts vehicles entering and exiting a rest area truck parking facility by using video cameras that monitored the entrance and exit ramps to the truck parking area without the involvement of human operators. It used this information to determine a count of available truck parking spaces. Image processing software in the cameras was designed to detect when a vehicle appears in the image. The image processing software distinguished between trucks, tractors, and other vehicles based on overall vehicle length. Vehicle detections were transmitted from the cameras to the onsite computer. The Autoscope Solo® Terra™ video detection system was the key element of the SmartPark video system.

Figure 6-10 Example Truck Parking Camera System. (SOURCE: Federal Motor Carrier Safety Administration.)

Truck Access/Movements – Air cargo roadway access data is often needed at airports with significant cargo trucking operations. Data collection tools include manual or hand held counters that are used for intersection and other visual count or classification studies performed by a field surveyor. For automated data collection, the "road tube" is the most common short term data collection method for traffic counting and classification. Two main reasons for this are that the data collected is accurate and economical compared with other detection methods. Road tubes are used to detect vehicle axles by sensing air pluses that are created by each axle (tire) strike of the tube in the roadway. This air pulse is sensed by the unit and is recorded or processed to create volume, speed, or axle classification data. While one road tube is used to collect volume, two road tubes can be used to collect speed and class data. When a pair of wheels (on one axle) hits the tube, air pressure in the compressed tube activates a recording device that notes the time of the event. Based on the pattern of these times (for instance, the length of the interval between the time that two axles of a typical vehicle activate the counter), the device will match each compression event to a particular vehicle according to a vehicle classification scheme.

Warehouse Bypass Truck Traffic – Some airports permit trucks transporting air cargo to pass through security gates to deliver or pick up air cargo directly on the aircraft apron. This practice allows for expedited cargo handling of large project cargo, cargo contained in ULDs as well as bulk loaded or loose cargo. Data related to this activity may be collected, via survey or interview, from air cargo businesses utilizing this practice or through observation of activity. Data collected would be similar to the truck parking area data collection with a focus on truck on ramp duration, size of truck and average tonnage transferred directly from the truck to the aircraft or vice versa. The cost for collecting the data via observation can be expensive since a field surveyor will need to be in position to collect the data for a period of time. Other sources of data include collecting of information from airport security records on who (company) has accessed the ramp via a cargo area security gate, and the length of time they were on the ramp. This data would not have the type and size of truck however. Another data collection tool would be the utilization of web based or security cameras that record traffic through these gates.

Cargo tug traffic to passenger terminal – Data collection regarding tug operations for transporting cargo to passenger airline aircraft are commonly overlooked in an airport master plan. Data needed for accurate analysis of these operations include distance from the passenger airline's warehouse to the passenger terminal, as well as average tug time and frequency of these operations. Data collection should also include the user's estimates of the sufficiency of the tug time and distance as well as ways to improve connectivity between the terminals and the warehouses. Surveys or interviews of tug lane users provide the best means of collecting the data. Observation by data collection team members is also a viable, but more expensive, method. Observation data will also miss out on the collection of the volume of air cargo transported during each movement.

Ground Service Equipment (GSE) – GSE needs space for: maneuvering equipment between the warehouse and aircraft, storing equipment when it is not in use, and storage of ULDs which may or may not contain cargo. Data collection efforts regarding GSE needs should also take into consideration the type of entities utilizing space for GSE. These primarily revolve around integrated express carriers, third party ground handlers, passenger airlines moving belly cargo and cargo carriers with freight aircraft which all have varying needs related to GSE. Passenger airlines, for example, do not need aircraft ramp space adjacent to the cargo warehouse but still require space for maneuvering and storage of tugs and carts. Surveys or interviews of carriers with GSE needs provide the best means of collecting the data. Aerial photos can be utilized by airport planners but would be fairly limited in determining the flow of GSE during peak periods of operation.

Hydrant Fueling – Hydrant fueling is typically required at cargo areas on airports where high volumes of Jet-A fuel are required for large aircraft. Airports that serve as air cargo hubs or international gateways to the air cargo industry benefit from hydrant fueling beneath the cargo apron as it cuts down on fuel truck traffic as well as expense. Data collection to determine whether a need exists within the airport's air cargo carrier community must take place with direct consultation with a cargo carrier's facilities planning/engineering division.

Peak Hour Cargo Aircraft Parking – Cargo aircraft parking demand can be provided from several sources. The tenant utilizing the hard stands and ramp area will likely provide peak hour parking information during the data collection effort. If this is not the case aircraft parking can be collected by airport planners and interns by conducting an air cargo aircraft parking survey. This would entail collecting aircraft parking data through observation. Through observation the planner can collect information related to arrival time, departure time, parking duration (waiting time), aircraft type and size. Airport planners can also use aircraft arrival and departure information gathered from the air traffic control tower or FAA databases to determine cargo aircraft arrival time, departure time, and parking duration.

SUMMARY

Chapter 6 identifies data gaps commonly found in the airport master planning process. It also describes the data gaps the project team experienced during the data collection phase of the project. The team details how data gaps related to specific surveys for this study were remedied through analysis tools provided by Google Earth Pro and other public documentation. The collected data is used to craft guidelines for air cargo facility planning and development at airports. The primary objective is to assist airport operators in utilizing effective planning practices and in making development decisions that meet the industry's current and future challenges. This chapter concludes with a discussion of efficient techniques to collect data on air cargo activity on airports. The next chapter focuses on air cargo forecasting techniques. Forecasts of air cargo facility demand will be translated into cargo facility needs.

CHAPTER 7: TASK 5—AIR CARGO FORECAST TECHNIQUES

CHAPTER OVERVIEW

The air cargo industry is faced with some of the most challenging forecast challenges of any industry. Forecasts based on historic trends analysis are increasingly less reliable as future trends cannot be solely based on activities and practices that have evolved into combined modes of both air and truck transport. Over the last two decades, the magnitude and complexity of air cargo forecasting has grown enormously and airport planners are faced with the daunting task of accurately forecasting air cargo tonnage and operations for extensive periods of time. In this paper we survey different approaches and methodologies to forecasting air cargo tonnage and operations. We conclude with a discussion of forecasts utilized in recent air cargo elements of master plans.

INTRODUCTION

The principal purpose of Task 5 is to explore methodologies used to forecast air cargo demand at U.S. airports, as well as how forecasts are applied on a practical basis to airport planning. Task 5 then surveys forecasting methods used in recent airport planning efforts with ample context pursuant to the cargo function at these airports. Task 5 concludes with a consideration of risk factors that can produce dramatic divergences from forecasts.

Generally, cargo forecasts are undertaken as part of an airports' Master Planning activity, an environmental assessment, to accommodate facility improvements or in response to unforeseen demand or expectations of the local business community. They are then utilized to assist planners in the identification of appropriate areas for future cargo facility and ramp improvements.

SOURCES OF INPUTS

Virtually all U.S. airports at least track total cargo volume, as well as subsets such as freight (including express) and mail on a directional (inbound and outbound) basis. Commonly, these data sets are managed by airport accounting departments compiled from monthly operations reports used to settle landing fees and satisfy other carrier reporting requirements. Whether disseminated publicly, this data is kept by the airport on a carrier-level basis which can be organized into market share by individual carrier and/or type (all-cargo versus belly). For those airports to which it is applicable, cargo will also be organized into domestic and international increments. In addition to tonnage data, monthly airline reports provide critical inputs pursuant to monthly frequencies and aircraft types. There is no single standard for how or if airports generate public reports from this and other data. While the web page of the Port Authority of New York & New Jersey contains extensive monthly data sets pertaining not only to airport operations but also to Customs entries by country and commodity, for example, other airports may include nothing more than a single entry for total annual cargo in their public reports. Almost all member airports report annual tonnages to Airports Council International – North America, which publishes a Top 50 data set by year on its web site and a more extensive set for members only. However, U.S. airports are not compelled to join ACI-NA and such major cargo airports as UPS's regional hub in Rockford, IL will not be found in ACI-NA's statistics.

Air cargo tonnage is typically reported by airports airport commissions and to the public on an annual basis but monthly reports are useful to isolate seasonal trends. While it is uncommon for carriers to report weekly or daily tonnage numbers, planners can use secondary references (such as OAG's Cargo Flight Guide) or request carrier schedules to record flight operations in peak period analysis – critical where aircraft parking ramp is at a premium. Aware of the limitations of individual references, it is advisable to use multiple sources of primary and secondary inputs. OAG's Cargo Flight Guide, for example, does not include schedules for integrated carriers and may also identify flights by ACMI carrier, rather than client.

A variety of institutional sources are commonly used to calibrate individual airport forecasts, including forecasts by Boeing, Airbus, IATA and the FAA. These are detailed later in this section, including an assessment of the strengths and weaknesses of each source. For specialized facilities – such as cold storage – airport planners may seek trade data originating with U.S. Customs & Border Protection (CBP) that can quantify monthly and annual tons by commodity type for both import and export shipments cleared at the local Customs port. Much trade data can be accessed at no cost from the U.S. Census Bureau and through subscriptions to governmental sources such as the Bureau of Transportation Statistics (BTS) TranStats service. Secondary commercial providers also sell packaged reports often blending public and proprietary sources.

There is no substitute for the unique perspectives obtained through original interviews and surveys with on-airport cargo-related tenants, as well as key off-airport constituencies. The former may include local station managers as well as corporate property managers and route planners who commonly have distinctive insights into carriers' intentions for the local market. Off-airport constituencies may include freight forwarders, trucking companies and major shippers (manufacturers and distributors) of time-sensitive commodities. Area economic developers may also provide insights and data characterizing the local origin-and-destination market.

METHODOLOGIES

Time Series Trend Analysis

One of the most common forms of statistical analysis is the discrete time series, which observes phenomenon through regularly spaced intervals. This is contrasted with the continuous time series, which records an observation at every instant of time. This analysis can be organized to measure trends which may be extended to forecast future values. To be used as a predictor, time series analysis requires confidence that the period to be forecasted will be much like the period from which the trend multiplier (usually a Compound Annual Growth Rate – CAGR) was derived. CAGR provides a "smoothed" rate of return describing yield on an annually compounded basis. One of its weaknesses is that it does not reflect volatility which can be substantial from one year to another but rather creates the illusion that there is a steady growth rate. It is noteworthy to point out that time series analyses are commonly used to "inform" airport planners of future growth rates based on historical activity but does not completely dictate growth rates since the market is susceptible to volatility.

For many years, a twenty year horizon was the accepted time frame for forecasting. Clearly, the early years had the greatest credibility with the most distant years the weakest. Airport activity has been volatile as the airline industry has been impacted by uncontrollable factors such as escalating fuel prices, economic swings and labor issues.

Longer historical periods are still often preferred but the beginning and ending years of the time series should be closely scrutinized for the effect that anomalous years can have on trend analysis. While it is customary to use increments such as decades in time series, a ten-year time series initiated with the extraordinary losses in 2002 would likely miss common peak years (useful in gauging historical capacity) from the late 1990s through 2000.

On the other hand, a longer time series must be qualified in terms of applicability because the industry itself has changed so greatly since the 1990s. As documented in Task One's "State of the Air Cargo Industry," the demise of former all-cargo tenants such as Airborne Express, BAX Global, Emery Worldwide and Kitty Hawk have left sprawling vacancies at on-airport cargo facilities. In many predominantly domestic air cargo markets, market shares of FedEx and UPS have risen from around 50% twenty years ago to over 90% in 2012. Such market consolidations may have the twin effect of emptying multi-tenant buildings of failed former legacy carriers while leaving the surviving dominant carriers more likely to have required single-tenant (stand-alone) facilities dedicated to their individual operations. The ultimate outcome is a dearth of prospects to backfill vacancies.

In international gateways, gains in international cargo tonnage have at least partially masked losses in domestic cargo. Total cargo tonnage may have changed very little in the course of twenty years, but the carrier composition may have changed dramatically. Similarly stark changes may have transpired in the mix of belly cargo market share versus freighter share.

Table 7-1 (with content already presented in Task One) reveals that a Time Series of Calendar Year 2000 through 2010 would produce a negative multiplier in almost every U.S. airport market. Removing FedEx hub Memphis and UPS hub Louisville from the integrator hub and the South Central airports group would produce a -23% and -22% group composite for the period, as opposed to net growth. Similarly, removing Miami’s contribution would make a -13% performance an even worse -31% for the Southeastern airports group.

Table 7-1 Air Cargo Growth/Decrease: CY 2000 – 2010 (inclusive).

Top 101 U.S. Airports	-12%
Integrator Hubs (13 airports)	6%
International Gateways (13 airports)	-7%
Northeastern (15 airports)	-28%
Southeastern (19 airports)	-13%
North-Central (25 airports)	-34%
South-Central (17 airports)	25%
Northwestern (13 airports)	-41%
Southwestern (12 airports)	-20%

SOURCE: Airports Council International, Webber Air Cargo Analysis.

Using growth rate multipliers derived from the period represented in the data of Table 7-1 for use in 20- to 30-year forecasts would have all but a rare few airports dwindling toward zero cargo by the end of the forecast periods. Fortunately, that level of pessimism is uncommon. Forecasts created in the last ten years have typically assumed that the bottom of the cycle had already been found and recovery would begin immediately. Unfortunately, forecasts based on that assumption have proven overly optimistic to date.

Even if only to provide a contrast, time series analysis remains a useful planning tool. If concerns exist pursuant to anomalous years of data, multiple analyses can use a variety of beginning and ending years. Regardless of the interval, charting market deterioration since past peaks illuminates how much facilities capacity may exist from an airport's past peak demand. The ideal use for trend analysis has been described as a mature industry experiencing relatively consistent, gradual growth – a description that contrasts greatly with the recent experience of the U.S. air cargo industry.

Regression Analysis (Econometric Modeling)

Regression analysis is a statistical technique for estimating relationships between a dependent variable and one or more independent variables. Regression analysis helps explain how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed.

Regression analysis is widely used for prediction and forecasting. Regression analysis is also used to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables with the critical caveat that correlation does not always prove causation.

The dependent variable of air cargo growth may be associated with such independent variables as jet fuel prices, gross domestic product (GDP), composite leading indicators (CLI) and population – customarily using a combination of time series and growth curves. Most U.S. airports only serve local or regional origin & destination markets. Therefore, cargo growth may track closely with local and/or regional economic attributes, so reliable functional relationships may exist between an airport's cargo growth and the area GDP, income and population growth. However at international gateways air cargo growth may be at least as influenced by economic conditions in origin and destination countries rather than by local economic conditions since air cargo is often trucked great distances across several states, or across the country in many instances, to these international gateway airports.

Econometric modeling (such as multiple regression analysis) is often perceived as more effective with broadly defined markets (countries and entire continents) in which multiple factors influence aggregate growth and other variables may be held constant. In this method there is an assumption that supply is unconstrained, which contrasts starkly with individual airports where cargo capacity is constrained by the hub-and-spoke systems of carriers and limited aircraft fleets. Any forecast strategy may (or may not) assume that capacity is constrained and planners/consultants need to decide when they forecast whether or not the forecasts should be constrained or unconstrained. There is value to both approaches, but master plans commonly assume an unconstrained local demand, so that the rest of the master plan can be focused on determining what facility plans are needed to accommodate that demand.

The ability of carriers to shift capacity between airports (market share shift), as well as between air transport and other modes (particularly trucking) pose substantial risks to the assumption of unlimited capacity supply that meets graduated demand. U.S. airports have experienced extraordinary growth (Greensboro, NC with FedEx) and losses (Des Moines with UPS) attributable to network adjustments by integrated carriers that seemingly had nothing to do with local cargo demand generation.

Like time series analysis, regression analysis is a useful tool to evaluate historical relationships between cargo growth and other econometric elements. However, it is an imperfect (wildly so in some circumstances) predictor of future trends – not least because of its assumption of unlimited capacity supply – and therefore should be considered only one of several potential analytical tools.

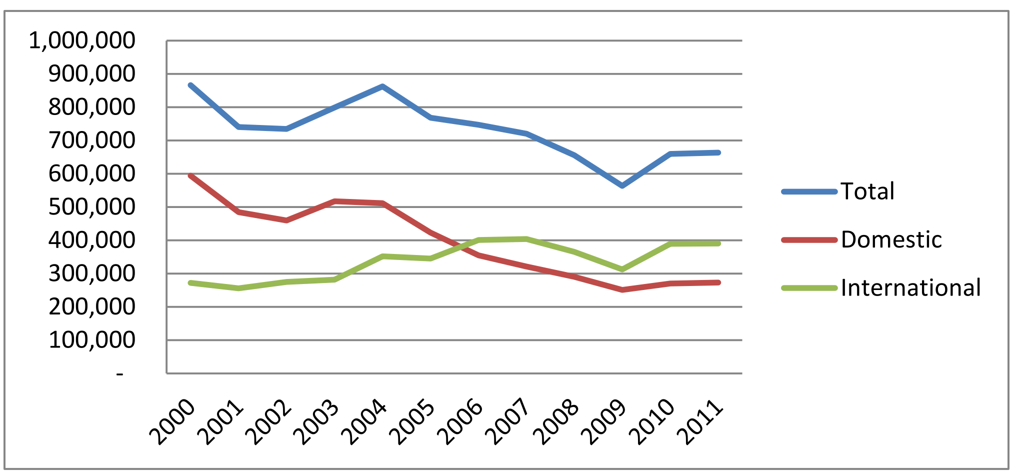
Market Share

Market share analysis compares local activity levels with a larger entity, most commonly in comparisons between a particular airport and its regional or total national traffic. Historical data is used to establish the ratio of local airport traffic to total national traffic – customarily using source data from the FAA Aerospace Forecasts document for national data.

Much like the preceding methodologies, Market Share has limitations as a predictor. Most obviously, this methodology assumes that the proportion of activity that can be assigned to the local level is a regular and predictable quantity. As has already been established, the U.S. air cargo industry remains in the midst of a prolonged period of contraction that has touched most airports but not equally. For example as in Figure 7-1 depicting Hartsfield-Jackson Atlanta International Airport, some gateways were able to offset some domestic losses with international gains.

Indications in late 2012 from the two dominant integrators suggested that near to medium-term domestic fleet utilization strategies may favor up-gauging aircraft size but serving fewer U.S. markets by air, while expanding the utilization of trucks for domestic feeder service. The impact may negate organic air cargo growth at many small and medium-sized markets or conversely may support growth at strategically located airports that can potentially serve as access points to multiple possibly larger markets. All of the preceding suggests that imperfections exist in market share modeling, as it pertains to projecting local airport trends relative to regional and national growth.

Figure 7-1 ATL Annual Cargo (Metric Tons): CY 2000 – 2011. (SOURCE: Airports Council International, Webber Air Cargo Analysis.)



Market share analysis at the individual airport-level is integral to understand how the market has evolved and therefore may indicate potential direction going forward. At the individual airport level, market shares of international and domestic, as well as belly cargo versus freighter cargo is essential for facilities planning as this analysis informs judgments about future demand for freighter positions and other related considerations. Carrier market share – possibly through the prism of ground handlers possibly serving multiple carriers in a common warehouse and ramp space – is necessary for calculating the individual utilization rates of cargo facilities. In summary, market share analysis is an essential piece of air cargo analysis at the individual airport level but as a predictor of future relationships between local and national trends, it must be qualified.

Institutional Forecasts

The introductory section cited several sources of institutional forecasts commonly used by airport planners and others to calibrate local cargo forecasts. For the vast majority of U.S. airports, only domestic cargo is materially significant, as international shipments of local origin/destination will either be trucked or flown on a domestic segment to a gateway with trucking increasingly likely and therefore negligible impact on the feeder airport's cargo totals. Forecasting inbound and outbound domestic cargo (and related translation into freighter operations) will suffice. However, at international gateways, directional (import and export) forecasts will often be segregated by region (for gateways with multiple transcontinental routes), although often a composite international multiplier entails the international market share and growth rates of each individual segment.

Using institutional forecasts is not a substitute for other methodologies but more accurately a surrogate for the labor involved. Entities such as Boeing and Airbus perform intensive econometric modeling (GDP and fuel prices, to name but two independent variables) to inform their biennial forecasts – typically with budgets and other resources well beyond the means of airport planners and even most consulting firms. In fact, the FAA often cites the Boeing forecast, in particular for use in its own efforts. However, just as the U.S. economy is comprised of regional economies that may little resemble one another – the Rust Belt versus the Farm Belt, for example – local airports may not conform precisely to national economic expectations. If such institutional forecasts are used as the basis for individual airport forecasts, adjustments should be made to recognize local conditions.

The latest Airbus effort is their "Global Market Forecast: 2012 – 2031." It is an integrated document entailing both passenger and cargo forecasts – contrasted with Boeing which releases separate reports. Passenger forecasts are available from both sources and may be of particular use in incremental considerations of belly cargo capacity versus freighter demand. Both Airbus and Boeing forecasts are available as free downloads from the corporate websites. Significantly, both companies' cargo forecasts project growth rates in terms of revenue-ton-kilometers, which clearly puts a premium on longer-haul segments (such as those over the Pacific), while airport cargo forecasts are typically expressed in cargo tons and flight operations as a derivative forecast. It should be noted that revenue-ton-kilometers is expressed as one ton of revenue-producing cargo flown one mile (Boeing) or kilometer (Airbus).

One disadvantage of the Airbus forecasts has been that detailed cargo forecasts have been produced in less reliable intervals – not surprisingly for a manufacturer that has struggled competitively in the freighter market. A significant advantage is that Airbus' market forecasts tend to be segmented into much smaller sub-continental groupings allowing more precisely delineated pairing of routes and markets. For international gateways with diverse networks of direct destinations, this advantage is invaluable. For airports where only domestic or perhaps only modest international service is offered, planners may use either (or both) the Airbus or Boeing forecasts for guidance. Whether one source is more conservative than the other is only evident on a segment-by-segment basis but not as a whole.

Boeing's "World Air Cargo Forecast 2012 – 2013" is the latest biennial installment of the cargo-specific document. Like the Airbus version, the Boeing twenty-year (through 2031 in the latest installment) forecast is compiled from econometric models and airline interviews undoubtedly enriched by Boeing's dominance in the freighter market and resultant access to the insights of the world's dominant freighter operators. While the Boeing forecasts are not as narrowly stratified as those of Airbus in terms of market segmentation, it has the significant advantage of a timely production schedule and relatively uniform structure over time – facilitating the reuse of forecast templates by airport planners. Perhaps its greatest virtue is that Boeing's cargo forecast is unlikely to meet any critical opposition, as they are so ubiquitous in the efforts of the FAA and others. Clearly, the popularity of Boeing's forecasts derives in large part to the acceptance of its methodology and its history of reliability.

The FAA Terminal Area Forecast (TAF) summary historical and forecast statistics on passenger demand and aviation activity at U.S. airports based on individual airport projections. The document (and its sources) is available for free download at the FAA's website. The TAF model can be accessed from the Internet so that model users can relatively easily generate their own forecast scenarios.

The principal input for the TAF is the FAA Aerospace Forecasts (Fiscal Years 2013 – 2033 just being released) which are developed from econometric models intended to explain the relationships and emerging trends for all major segments of air transportation. Typical of econometric models, the FAA Forecasts assume unconstrained capacity. They also assume no further contractions of the industry through bankruptcy, consolidation, or liquidation. Even since publication, these assumptions have likely already been significantly compromised and the FAA wisely filled its narrative with cautions accentuating the recent unpredictability of commercial aviation. Both the FAA Aerospace Forecasts and the TAF are repositories of economic data that may be useful in conducting regression analyses. They also possess forecasts for passenger activities useful in considerations of potential belly capacity available for cargo.

The air cargo element of the FAA Aerospace Forecasts (in revenue ton miles – RTMs) assumes that security restrictions on air cargo transportation will remain in place and that most of the shift from air to ground transportation has already occurred. Finally, the forecasts assume that long-term cargo activity will continue to be tied to economic growth. While obviously uncertain, these assumptions are defensible. The forecasts of RTMs were based on models linking cargo activity to GDP with domestic cargo RTMs linked to real U.S. GDP as the primary driver and international cargo RTMs based on world GDP growth (adjusted for inflation). Distribution between belly and all-cargo carriers was forecasted on the basis of historic trends in market shares, changes in industry structure, and market assumptions.

The International Air Transport Association (IATA**)** produces an annual cargo-specific forecast that is stratified into more narrow market segments than any of the preceding forecasts. Its liabilities include that the detailed version must be purchased (unlike the three free downloads previously cited) and it is only completed in 5-year increments. In fairness, it should be noted that IATA only forecasts in 5-year increments due to the belief that forecasts beyond that horizon are so seriously compromised as to be virtually meaningless. That is an assessment with which many industry observers agree.

Potentially among the most illuminating sources of forecasts would be the air carriers which commonly develop in-house forecasts with 5-year increments being common for traffic and 5-10 year increments for fleet forecasts. Particularly at hub airports where a single carrier has a commanding share of belly cargo and at the many airports where FedEx and UPS may have combined market shares in excess of 90%, carrier forecasts would be invaluable. Unfortunately, these forecasts are considered commercially sensitive and therefore rarely shared with airport operators and/or their consultants. However, the preferred collaborative process of developing forecasts should present the opportunity to at least test the airport's own forecasts against perceptions of the carrier-tenants. Moreover, the carriers will typically provide input into operations forecasts pursuant to fleet expectations for the near to mid-term.

Operations Forecasts

Airports' cargo operations forecasts are principally derived from tonnage forecasts. As much as tonnage is a critical input for planning warehouse capacity, operations are critical for planning ramp capacity. Airport planners need as much feedback as possible pursuant to carriers' fleet and route planning. While the gauge of aircraft is critical to calibrate aircraft capacity, it is also critical to know how much of the payload is dedicated to the local market. If the aircraft continues to other cities to build/break loads before returning to the hub, partial loads decrease throughput anticipated for the warehouse and may shorten the time the aircraft will be on the ground.

A thorough understanding of airline schedules may allow airport planners to maximize the use of aircraft ramp positions by getting multiple turns on a single position when schedules are compatible. Moreover, a carrier may be able to double or triple its local tonnage without adding another operation if its current payload dedicated to the local market is small. These considerations are particularly important at international gateways such as ATL and DFW where international freighter operators commonly share multi-stop service with other gateways. Clearly, this information must also be reconciled with the actual capacity of each ramp position in terms of the maximum gauge of aircraft that can be accommodated.

Airport planners can extract current fleet and flight operations data from landing reports and flight schedules from proprietary sources such as OAG Cargo Flights. Industry-wide fleet information can also be gained from Airbus and Boeing, as well as from outstanding secondary sources such as Cargo Facts produced by Air Cargo Management Group. Both OAG and Cargo Facts are available on a subscription basis. No matter how credible the secondary sources, interviews with cargo carriers (and handlers where applicable) are indispensable to verify potentially outdated secondary sources, as well as to gain unique forward-looking insights into prospective future operations on a specific market basis.

In order to derive operations from tonnage, airport planners must first determine the market share presently transported by passenger carriers (therefore not contributing to freighter operations) and then make assumptions about future trends pursuant to that distribution. The FAA Aerospace Forecast provides such forecasts for both domestic and international cargo on a national airport system basis.

Once that belly cargo has been deducted from total cargo to isolate the tonnage that specifically drives demand for freighter operations, planners must make assumptions about the carriers' payload limits that would trigger either additional frequencies or a change in gauge of aircraft. Again, it is also critical to know how the local market is presently served by the carriers – as a stand-alone destination or as part of a multi-stop routing – in order to evaluate how much capacity is available before another frequency would be required. Unlike passenger service that very often is daily, freighter service at many U.S. airports may only be weekday with perhaps partial service on weekends. Consequently, airport planners may use an annual standard of 282 annual cargo days (5.5 days/week), adjusting according to local schedules which may only have weekday (5 days/week or 260 days/year) or alternatively full calendar (7 days/week) service. Operations will typically be forecasted on a three-tier basis compatible with tonnage forecasts on a low, base and high case scenarios. Additional matrices can easily be formed to create alternative forecasts on the basis of a range of load factors.

While the more nuanced approach for deriving operations from tonnage just described is appropriate for airports served by a variety of carriers, planners at airports with relatively modest cargo operations may opt for a simpler approach comparable to the "market share" methodology described earlier. Applied to operations, the approach would entail simply calculating the tons/operation that the airport has recently experienced and then applying that average to future tonnage forecasts. On an applied basis, airport planners may combine the tons/operation with the airport's number of ramp positions (recognizing variable capacity) and aircraft turns per day per position, in order to determine total ramp capacity in tonnage terms.

METHODS USED IN RECENT AIRPORT PLANNING EFFORTS

During this study's Literature Review, the consultants reviewed twelve airport master plans completed between 2005 and 2011, analyzing the methodologies used in air cargo volume forecasts and air cargo operations forecasts.

For air cargo volume forecasts, the master plans primarily used traditional methodologies dependent upon statistical models and factors such as the airport's historic air cargo volumes (time series), and global, national, and local air cargo, as well as socioeconomic trends and forecasts. However, four master plans used market share approaches or probabilistic forecasting.

A minimal number of airport master plans used unique approaches to forecasting air cargo aircraft operations. As described in this section's earlier methodology briefs, standard techniques involved consideration of historical air cargo tonnage per aircraft operation, existing and future aircraft sizes, as well as global and national forecasts prepared by Boeing, Airbus, and the FAA.

Among the rare exceptions, one airport (FedEx western regional hub Oakland) used a methodology that involved development of average annual day cargo schedules and another used probabilistic forecasting. Forecasting methodologies of the twelve airports are summarized in Table 7-2 below.

Table 7-2 Airport Master Planning Documents Reviewed and Analyzed.

Airport	City	ACI Cargo Volume Rank 2011	Cargo Activity	Prime Consultant	Year	Cargo Volume Forecast Method
Boise Airport, BOI	Boise, ID	74	Non hub	Ricondo & Associates	2010	National and historic trends.
Capital Region International Airport, LAN	Lansing, MI	94	Non hub	RS&H	2006	Historical trends.
Cincinnati/ Northern Kentucky International Airport, CVG	Cincinnati, OH	17	Non hub (at time of analysis)	Landrum & Brown	2005	None.
Dallas / Fort Worth International Airport, DFW	Dallas Fort Worth TX	11	Hub	URS	2009	Blended growth rates.
Dona Ana County Airport, 5T6	Santa Teresa, NM	NA	Non hub	WHPacific	2008	Blended growth rates and market share based on El Paso cargo activity.
George Bush Intercontinental Airport, IAH	Houston, TX	15	Gateway	DMJM Aviation	2006	Local and national economic trends.
Kansas City International Airport, MCI	Kansas City, MO	45	Non hub	Landrum & Brown	2009	Historical trends.
Memphis International Airport, MEM	Memphis, TN	1	Hub	Jacobs Consultancy	2010	FedEx trends and historic trends.
Oakland International Airport, OAK	Oakland, CA	12	Hub		2006	Average Annual Day.
Piedmont Triad International Airport, GSO	Greensboro, NC	46	Hub	Jacobs Consultancy	2010	Boeing and Airbus, Historic belly and mail.
Portland International Airport, PDX	Portland, OR	28	Gateway	Jacobs Consultancy	2010	Econometric model & probabilistic forecasts.
San Antonio International Airport, SAT	San Antonio TX	33	Non hub	AECOM	2010	Blended growth rates.

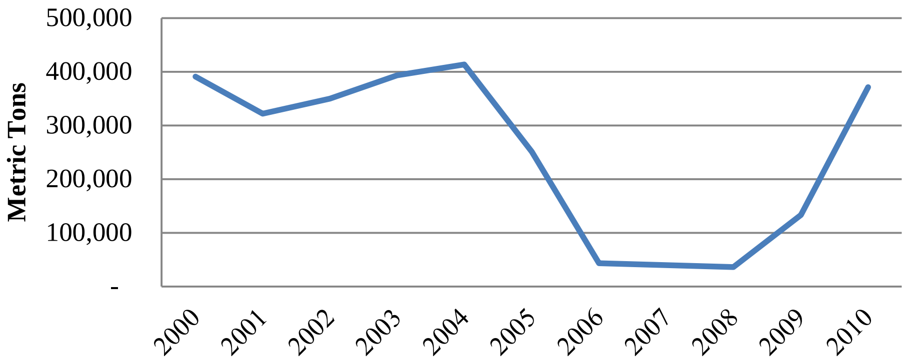
SOURCE: CDM Smith Analysis.

Typical of all of the airport forecasts was a pronounced tendency to assume that the air cargo industry's challenges were already past and that recovery was imminent. In Boise's case, the forecasts prepared in 2006 (using 2005 as the base year) predicted an accelerated CAGR of 4.0% for the first ten years, falling slightly to a CAGR of 3.8% per annum through 2030. Instead cargo fell almost 2% per annum for the first six years of the period. Boise's relative isolation may keep it from losing dedicated all-cargo service but its dependence on FedEx and UPS may portend fewer operations but with larger aircraft.

Lansing's tonnage forecasts were informed by several regression analyses with the strongest correlation between the population of the state of Michigan and air cargo growth at Capital Region International Airport. Aircraft operations were then formulated based on historical relationships and forecasted air cargo tonnage. Again, Lansing's forecasts projected a CAGR of 3.5% from 2000's 65.2 million pounds of total cargo but the airport's cargo actually fell more than 18% for the period through 2010.

Cincinnati/Northern Kentucky International Airport's forecasts provided relatively scarce detail pursuant to forecast methods. As the international gateway for DHL, the airport's cargo fortunes have tracked closely with the all-cargo carrier, especially since the demise of the former Delta Airlines hub at CVG. The last decade found DHL first abandoning its CVG hub in favor of the former Airborne Express hub at Wilmington, OH, then returning to CVG as a leaner, international forwarder and consolidator rather than the former domestic integrator it had principally been. While an extreme case, CVG's reliance on DHL accentuates the volatility, producing a growth pattern (Figure 7-2 below) that no analyst likely would have anticipated.

Figure 7-2 DHL Legacy Hub at CVG: Total Annual Cargo (Metric Tons): CY 2000 – 2010. (SOURCE: Airports Council International, Webber Air Cargo Analysis.)



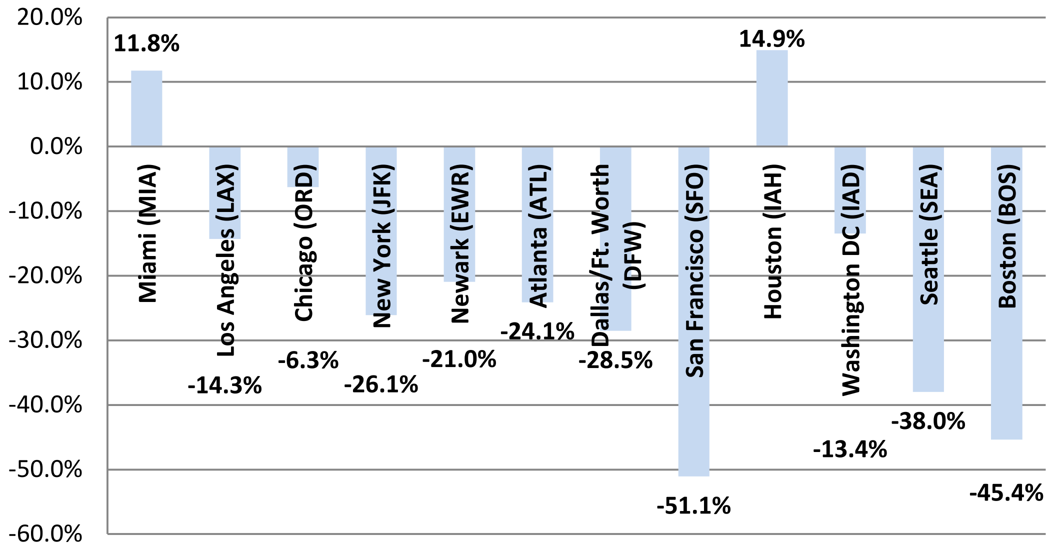
Dallas / Fort Worth International Airport (DFW) completed forecasts during its master planning process, prepared in 2007 but using 2006 as the base year. Unusually, the forecasts were based on only four years (2003 – 2006) of historical data due to the assumption that market conditions had changed so completely after 9/11 to render previous experience meaningless. Baseline forecasts were prepared for all-cargo carriers, integrators, and belly cargo carriers, as well as an alternate high-growth scenario assuming expansion of the UPS regional cargo hub at DFW. Apart from the unusually slight four years of historical data, other aspects of the forecasts were conventional, meshing assumptions about regional market share and Boeing's institutional forecasts. DFW's forecasters assumed an immediate industry recovery that still has not happened and as a result, (as of 2010) DFW's total cargo was already 31% below forecast: all-cargo carrier tonnage was 21% below, integrator cargo was 30% below and belly cargo was 47% below forecast, just four years into the forecasted period. As forecasted tonnage was converted into operations, no recognition was given that all of DFW's international freighters were shared on multi-city routes and therefore may require adjustment of tons/operation.

Dona Ana County Airport (DOCA), located in Santa Teresa, New Mexico, is a general aviation airport with a service area shared with El Paso International Airport. The airport is only 21 miles from downtown El Paso, TX. With the larger airport as the principal commercial gateway for the region, the general aviation airport's principal function has been ad hoc charters. Its 2005 annual cargo total of 270 tons was its highest since 1990. Its tonnage forecasts were prepared based upon reviews of historical air cargo data and previous air cargo forecasts prepared by Boeing and the FAA, as well as econometric analysis using projections of population, employment and earnings in the service area. The forecasts also used a model borrowed from the 2003 New Mexico Airport System Plan.

Appropriately, the tonnage forecasts acknowledged the dominant role of ELP in the area but in spite of finding that ELP could accommodate forecasted demand through 2025, the consultants still produced a cargo forecast for DOCA anticipating that the airport could capture growing maquiladora and local demand, regardless of the superiority of facilities and air service at ELP. The forecast estimated that 11,100 tons of annual enplaned air cargo could be captured by 2025 – equated to two daily Boeing 737-300SF freighter operations. The forecast of 11,100 annual tons seems modest until it is compared with the airport's current record year of 270 annual tons.

As detailed in an earlier section on the state of the air cargo industry (detail repeated in Figure 7-3 below), George Bush Intercontinental Airport (IAH) has been one of very few U.S. international gateways to experience air cargo growth between 2000 and 2010, enabled by its energy-based local economy, growth by its hub passenger carrier and network adjustments by integrators.

Figure 7-3 U.S. International Gateways: Total Annual Cargo Growth: CY 2000 – 2010. (SOURCE: Airports Council International, Webber Air Cargo Analysis.)



Completed in 2006, IAH's Master Plan's cargo forecasts were based on a review of historical trends at the airport, regional economic indicators, and evolving industry trends. Key assumptions included:

- Air cargo growth will be primarily driven by local and national economic trends.
- Passenger airlines will continue to account for the majority of the air freight and mail activity.
- Local market consolidation (e.g., UPS's move from Ellington Field in 2003) will force more air cargo traffic through the integrators' local hubs.
- Improved international air service will further garner forwarders' consolidations.

Based on these assumptions and the fleet mix forecast developed in the Master Plan, forecasts of cargo pounds per departure were developed. Air carriers' cargo operations were projected to grow by 2.8% per annum through 2025, from 9,186 operations in 2003 to 17,000 operations in 2025. Cargo commuter operations were projected to grow at an accelerated rate. By virtue of IAH's total cargo having grown during this challenging period, its forecasts have likely tracked more closely with actual experience even while using very similar methodologies to those used at U.S. airports with more typical losses.

Kansas City International Airport (MCI) serves an area larger for its geographic breadth than its presence of population or industry. Kansas City's central location has made it a dominant gateway for rail and trucking but a marginal air cargo airport. The airport has no significant international cargo capacity, no integrator hub and no passenger hub. Tellingly, the most notable cargo facilities growth has been for a trucking company specializing in hauling international cargo to/from major gateways to feeder markets. Its Master Plan (completed in 2006 and accepted in 2008) acknowledged the airports' limitless capacity for development but the market's limitations in generating demand.

At the time, the integrators had a 92% cargo market share at MCI. The forecasts took account of potential effects of air cargo security requirements, historical trends (local and national), consumer demand, local business investment and modal competition. The forecasts assumed that air cargo growth would resume over the forecast period but that the airport would not likely secure international cargo service during the planning period. In essence, MCI would continue to serve the origin and destination market but would not assume the kind of regional and national role that Kansas City serves in other modes. The forecasts projected a modest CAGR of 2.1% for the period, discounting institutional forecasts (such as Boeing's) higher growth rates perceived as more likely accruing to hubs, rather than pure feeder markets. All-cargo operations were forecasted based on assumptions that netted projected belly cargo, then applying MCI's existing and projected aircraft fleet mix based on interviews with the tenants. Local cargo tenants and the airport operator readily accepted the modest expectations.

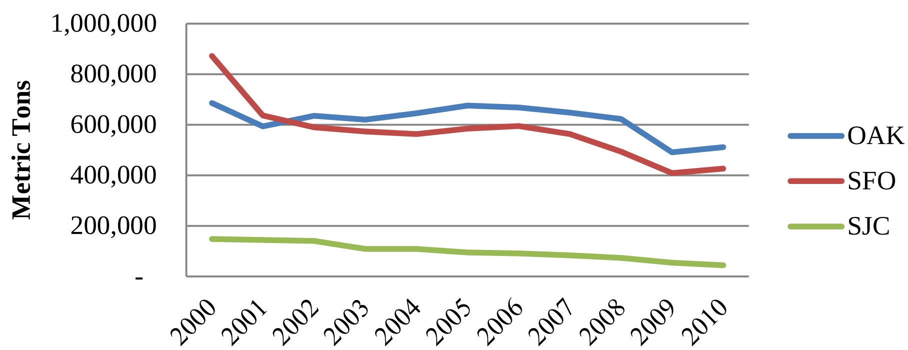
With its FedEx hub accounting for a 98.7% market share of airport cargo, Memphis International Airport (MEM) has led U.S. airports in annual cargo for many years. Consequently, MEM's cargo outlook is tied to the network activity of only one carrier (even more as its former passenger hub has been downsized in the wake of Delta's acquisition of Northwest) and should have a greater functional relationship to national and international economic conditions, than to the local or even regional markets. For its last Master Plan update, MEM had two forecasts prepared: A forecast exclusively for FedEx Express based on market drivers unique to that carrier and another for all other cargo carriers that use MEM more for local demand. At least in terms of distinguishing between demand drivers, the two-faceted approach seems like a reasonable accommodation. While typical low, baseline and high forecasts were created, following the FAA's review only the baseline scenario was used in the Master Plan Update. In this scenario, FedEx Express' air cargo tonnage was forecast to increase at a CAGR of 2.1%, while air cargo handled by all other carriers was forecast with a CAGR of 4.6%. The disparity is understandable, given that the growth for FedEx Express at MEM applies to an existing base likely without peer for one carrier at any other airport in the world. Translation from cargo tonnage to freighter operations was completed conventionally in terms of methodology but with the unconventional context of being so heavily driven by a single carrier and its fleet expectations.

On a much smaller scale, Oakland International Airport (OAK) parallels Memphis in that OAK is a Western regional hub for FedEx which had about an 80% market share (with UPS controlling another 15%) when OAK's last Master Plan was finalized in 2006. Unlike MEM, OAK shares its own regional market with the area's dominant international gateway, San Francisco International Airport, and to a lesser degree with San Jose. Forecasts were prepared through 2025 using 2003 as the base year for air cargo tonnage.

The methodology considered potential markets for future air cargo growth and identified an air cargo growth scenario based on historical growth rates at OAK, SFO and Norman Y. Mineta San Jose International Airport, as well as the maturity of the air cargo market at OAK. The forecasts also reviewed air cargo forecasts from the 2000 Regional Airport System Plan (RASP) and the ADP's 2003 Supplemental Environmental Impact Report (SEIR), as well as growth rates from historical data, RASP, and SEIR to generate growth rates for OAK, ranging from 3.59 to 7.84% with the former (low rate) used to project future cargo tonnage. The use of the low rate acknowledged the unlikelihood that OAK would successfully capture greater regional market share and that the Port of Oakland would not aggressively encourage rapid air cargo growth due to external influences.

Air cargo operations forecasts were prepared through development of Average Annual Day (AAD) air cargo schedules for 2003 and 2010. In the document, the preference for AAD over average day peak month (ADPM) was explained because unlike airline passenger activity, air cargo volumes were perceived to be relatively constant throughout the year. The regional approach to airport cargo forecasting may apply in some circumstances, as long as it is at least adequately explained in the forecast's narrative. As represented in Figure 7-4, it is unlikely that any methodology would have forecasted a roughly 25% decrease in annual cargo at OAK, a 51% drop at SFO and a 70% drop at SJC between 2000 and 2010 (inclusive).

Figure 7-4 Bay Area Airports: Total Annual Cargo (Metric Tons): CY 2000 – 2010. (SOURCE: Airports Council International, Webber Air Cargo Analysis.)



Piedmont Triad International Airport (GSO) in Greensboro, NC was another exceptional case among U.S. airports in that – due to the opening of a FedEx regional hub during the period – it experienced 24% net growth in air cargo between CY 2000 and 2010. While relatively impressive, that growth still left GSO considerably smaller than other regional hubs in the FedEx Express network and was substantially smaller than projected when the GSO was first announced as FedEx's Mid-Atlantic hub.

GSO's latest Master Plan Update was finalized in September 2010 with forecasts for the period 2007 to 2030. However because the FedEx expansion was ongoing at the time, only all-cargo volumes for GSO's other all-cargo carriers were forecast in the Master Plan Update – excluding the dominant carrier. The forecasts considered Airbus and Boeing's forecasts for U.S. domestic air cargo, arriving at an average of 3.1% used to forecast all-cargo tonnage at GSO (again, segregating FedEx's dominant contribution).

GSO's limited belly cargo (900 MTs/year) were forecasted to merely be maintained. The forecasters did include FedEx Express and Mountain Air Cargo in the forecasts of all-cargo operations. Forecasts for the new sort hub used estimates from the Environmental Impact Statement for a recent runway extension. Forecasts for all other all-cargo carriers were based on historical ratios of tonnage/operation, adjusted for future fleets.

Portland International Airport (PDX) is a major commercial airport in the Pacific Northwest with limited international service, including transpacific freighter flights operated with a subsidy to Asiana. Subsidies to international carriers have been a staple among gateways in that region, given competition between Portland, Seattle and Vancouver. PDX experienced a 32.6% decrease in annual total air cargo, falling from around 282,000 MTs in 2000 to only a little more than 190,000 MTs in 2010.

A Master Plan Update was begun in 2007 and finalized in 2010. Unconstrained air cargo volume forecasts were prepared using 2006 as the base year and 2035 as the planning horizon year. Given references to the extraordinary influence of base years in forecasts, it bears noting that 2006 was actually PDX's peak cargo year and its tonnage fell about 33% in just the four following years. The forecasts entailed development of an econometric model that related cargo tonnage to total personal income for the Portland-Vancouver region, as well as development of probabilistic forecasts of air cargo tonnage. Probabilistic forecasting allows for assessment of the uncertainty associated with future aviation demand. PDX air cargo was projected to grow at 3.3% through 2035 but has shrunk by roughly 33% since the base year. Estimates of shares between aircraft size were completed and then total air carrier cargo operations were calculated by dividing the cargo tonnage to be carried by all-cargo carriers by estimates of cargo tons per departure for both air carrier and commuter aircraft.

San Antonio International Airport is the primary commercial service airport serving its own metropolitan area but competes with Austin for regional traffic. After a period during which Austin's high-tech industry had swung the balance toward Austin, San Antonio's superior heavy industry base has recaptured some of its losses. Comparatively speaking, SAT's having only experienced a 0.7% decrease in total cargo between 2000 and 2010 could be considered a triumph, especially compared with Austin's roughly 57% decrease for the same period.

Unconstrained air cargo volume forecasts were prepared for SAT for the period 2008 through 2050, using forecasts by the FAA, Airbus and Boeing as benchmarks. The forecasts assumed:

- Future growth in GDP would largely determine future cargo tonnage.
- U.S. domestic air cargo growth would lag international growth.
- The now mature Express market would slow from its 1980's and 1990's growth rates.
- High fuel and other operating costs would continue to support diversion to truck transport.
- Belly cargo would continue to decline with only some shifting to all-cargo carriers.
- Air freight would grow at a high rate than mail

According to the baseline, cargo tonnage was forecasted to grow at 3.3% through 2050. The Master Plan provided little information pursuant to how all-cargo aircraft operations forecasts were derived but projected only a 2.5% growth rate, possibly suggesting larger aircraft to accommodate a slightly higher growth rate in tonnage than in operations.

RISK ASSESSMENT

A variety of forecast risks have already been referenced in preceding descriptions of individual methodologies. Rarely have such risks been more obvious than in recent years when air cargo forecasts have routinely diverged dramatically from actual results. Not only was the collapse of the last decade relatively unforeseen but analysts have repeatedly misidentified what was perceived as the low point of the industry recession.

Consequently, the usefulness of a conventional time series (trend analysis) has been greatly compromised as a predictor since it somewhat requires a belief that "past is prologue" even as most industry participants hope to never experience another decade like the last. Time series can also be wildly skewed by anomalies at either the start or finish year of the historical period under review.

Econometric modeling also requires faith that the past is a reliable indicator of future activity, typically linking historical relationships between cargo growth rates and other economic variables – such as GDP. Typically, such models assume unconstrained capacity but the ability of airlines to shift between modes and service points greatly undercuts the reliability of that assumption.

Using institutional forecasts such as those of Airbus, Boeing and the FAA to calibrate local growth rates is certainly defensible. However, each of those forecasts is national in scope while the U.S. is comprised of individual markets that have tended not to move in economic lock-step. Moreover, the forecasts are actually in revenue-ton-miles, rather than strictly tonnage. Should any of these forecasts be used, airport planners should consider adapting the national forecasts to recognize local trends.

Because air cargo operations are typically derived from tonnage forecasts, any inaccuracies in the latter will carry through the former. Moreover, airport planners must recognize when carriers are splitting payloads among multiple markets and similar schedule and equipment nuances. Split service may result in quicker turns – since only a portion of the aircraft is loaded and unloaded – allowing for more frequencies per ramp position. The carrier has the potential to grow tonnage without adding frequencies simply by increasing the share of payload dedicated to the market, potentially growing from split to fully-dedicated service. Alternatively, a carrier may choose to eliminate split service at the weaker of two service points in favor of trucking to/from another gateway. The preceding also underscores the fluidity of freight flows in that demand growth may be accommodated in more ways than simply additional flight operations.

In addition to all of the preceding, cargo forecasts could be dramatically affected toward the negative by increased diversion of intercontinental cargo from air to ocean transport, as well as any acceleration of the recent mass migration of domestic cargo from air to trucks. Cargo operations may also be affected by spikes in fuel prices that could make freighters more challenging to operate profitably, while a decrease in fuel prices may cause carriers to resurrect freighters that have been parked due to fuel inefficiency but which still had utility otherwise.

ACRP Report 76 Addressing Uncertainty about Future Airport Activity Levels in Airport Decision Making, completed in June 2012, provided a guidebook and systems analysis methodology to (1) identify and characterize risks and opportunities; and (2) enable airport management to address risks and opportunities in their business models.

SUMMARY

Both in descriptions of methodologies and in examples from a dozen U.S. airports, this section summarized a variety of techniques used to forecast airports' cargo tonnage, as well as to derive all-cargo operations from that forecasted tonnage. Forecasts for cargo tonnage and flight operations have direct implications for warehouse and ramp capacity planning, respectively.

Distinctions arise on a case-by-case basis. Warehouse throughput may be closely tied to freighter operations at the vast majority of U.S. airports where all-cargo carriers dominate. At international gateways, belly cargo often accounts for more significant market shares. When freighter service is shared among multiple stops on a single aircraft, warehouse space required to accommodate only a partial freighter payload is reduced but an entire freighter position, as well as ground service equipment, is still required on-ramp. The length of time that position will be required may be reduced by a quicker turn from unloading/loading only part of a freighter's payload.

Rather than depend upon a single forecast methodology, airport planners should adapt and incorporate a variety of techniques suited to the individual market. Planners must avail themselves of ample primary data sources through interviews and surveys of current air cargo tenants and potential prospects, in order to introduce local conditions into what can otherwise be completely secondary, remote sources.

Cargo forecasts cited for specific airports in this section typically diverged dramatically from actual experience in the forecast period to-date. Nothing in the Forecast Techniques Task should be misconstrued as criticism of either the methodologies or the forecasters. Industry veterans suggest that they have never experienced a period as challenging as the period since Calendar Year 2000 and the data substantiates that claim. With an expectation that forecasts may miss the mark – dramatically, in many cases – analysts must be especially attentive to documenting their assumptions and describing their methodologies so that interim updates can be completed without the need for comprehensive Master Plans or Updates to be completed on a continuous basis.

The focus of next chapter is to develop planning metrics and functional relationships that enable a translation from forecasted demand to specific air cargo facility requirements.

CHAPTER 8: TASK 6—AIR CARGO FACILITY REQUIREMENTS

CHAPTER OVERVIEW

The scope of work for this subtask sought to link industry trends with their effect on air cargo facilities planning metrics. Task One of this study provided an overview of the air cargo industry and recent trends and subsequent tasks similarly provided foundation for this subtask.

Previous tasks have organized U.S. airports into sub-groups according to such attributes as whether airports are international gateways with relatively greater diversity of carriers or almost entirely dominated by one or two integrated carriers – specifically FedEx and UPS. Such frameworks are essential for organizing data and analysis, yet such divisions are rarely absolute. A single airport can be both an international gateway and a regional integrator hub (Newark, for example) and a gateway may have all of its international capacity provided by belly carriers (Washington Dulles) or predominantly freighters (Miami).

BASIC TRENDS

The substantial depth of analysis in Task One leaves no need to repeat whole segments of that analysis but it merits emphasizing that an unprecedented surplus of cargo facilities has been left at the vast majority of U.S. airports by the terminations and acquisitions of a variety of former major cargo carriers, the diversion of shipments from air transport to trucking and the loss of market share from belly carriers to integrators in the domestic market. The outcome for many U.S. airports has been double-digit decreases in annual tonnage from the peaks of the late 1990s and widespread vacancies in once-bustling cargo facilities.

Even at airports – principally international gateways – spared the worst losses, the transfer of market share between types of carriers and evolution of operations (such as the outsourcing of cargo handling) have rendered surplus facilities poorly suited to prospective new cargo tenants. The severe losses have dramatically changed the landscape of cargo facility needs in the U.S. market. Concerns in the late 1990's that inadequate facilities capacity might constrain cargo growth have turned into a surplus that hobbles even potentially once justifiable cargo expansions and/or improvements.

EFFECTS: WAREHOUSE

The effect of these industry trends on capacity utilization has been more derived than direct. Warehouse utilization rates – measured by annual tons handled per square feet – have often fallen precipitously due to severe drops in throughput rather than inefficiencies. This study’s analysis has attempted to reconcile that issue by using occupied rather than total capacity – netting out vacancies – but often cargo operators have retained excess space either due to long-term leases or because of hope for a near-term improvement that has not occurred to date.

In addition to the effect of the drop in annual tonnage (with throughput being the numerator in measures of utilization), the shift in market share between belly carriers and all-cargo carriers – particularly integrators – also has affected utilization. For operational reasons already explained in other chapters, belly carriers have relatively lower utilization rates than all-cargo carriers, so the migration of market share from relative parity between belly and all-cargo tonnage in the early 1990s when many cargo facilities were built versus the present dominance by integrated carriers necessarily affects expectations for warehouse utilization. That change would be less evidenced by changes within the utilization matrix than in how market shares have been reapportioned between types of carriers.

As has been previously noted, the most negative effect of this migration of market share for most U.S. airports has been the obsolescence of some legacy cargo facilities. These facilities may not have exhausted the engineered lifespan but have no near to mid-term prospects for their designed utilization, given the dearth of air cargo carriers left in the U.S. domestic market. In building their dominant market shares, FedEx and UPS were most likely to move into dedicated single-tenant facilities which only exacerbated the vacancies in legacy multi-tenant facilities where the remaining tenants had plummeting cargo tonnage.

With such chronic shortages of tenants and no relief in sight, airport operators may need to confront whether some existing legacy facilities should be either designated for reuse or even razed. In terms of warehouse utilization ratios, the net effect would be to decrease the denominator (square footage) but again the driver would not be a gain/loss in operating efficiency but rather the elimination of unneeded capacity.

While much of the preceding has applied to the vast majority of U.S. commercial airports at which at least 90% of annual tonnage is now carried by FedEx and UPS, other shifts have been common at international gateways. The outsourcing of cargo handling has commonly resulted in higher utilization rates as multiple carriers may be handled in the same space formerly occupied by one or two – often by handlers' adding of labor and shifts. The same basic efficiency gain has also accrued to arrangements in which carriers (often a passenger hub carrier) leverage their staff and facilities to handle other carriers' cargo needs.

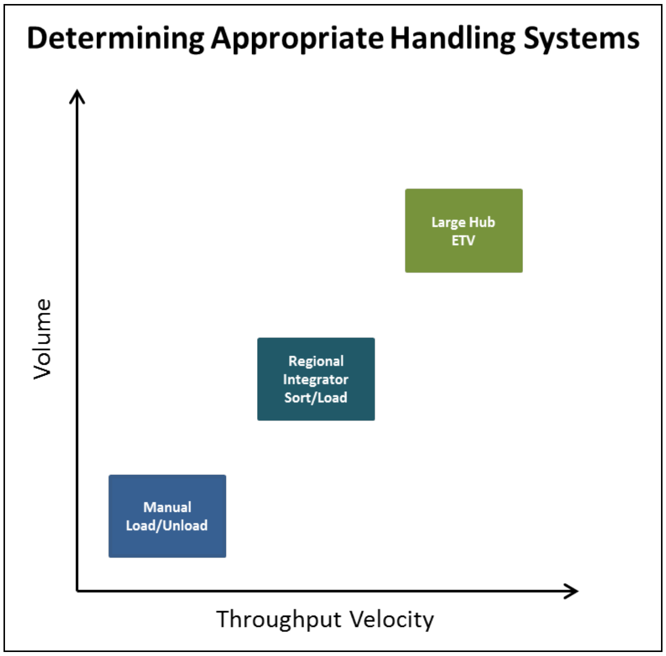
EFFECTS: CARGO WAREHOUSE AUTOMATION SYSTEMS

When considering the entire universe of air cargo within the U.S. one finds the majority of tonnage concentrated at cargo hubs and gateway airports, rather than being equally spread across the entire U.S. airport network. In fact, analysis of ACI cargo tonnage data indicates that the total tonnage of the top 20 airports in cargo tonnage in the U.S. comprises 80% of all cargo enplaned and deplaned at the top 150 airports. The primary driver for these large volumes of cargo at these top 20 airports, are integrated express hubs, (at seven of the 20), and the global trade reflected in large volumes of imports and exports. These international gateway and hub airports then must be able to accommodate a large amount of cargo in a relatively short period of time. Cargo warehouses then are not really warehouses at all but are terminals, similar to passenger terminals, with capabilities to handle rapid change and flux, with dramatic variations in hourly demand. The cargo terminal serves four principal functions:

- conversion (break down and buildup of cargo pallets and ULDs),
- sorting, (arranging ULDs and cargoes by airline, destination, and flights),
- storage (on a short term basis), and
- facilitation (customs, etc.) and documentation.

Typical air cargo handling methods range from very manual and labor intensive to highly automated and depend largely on the volume and speed of cargo handling required at each airport. As previously mentioned, the air cargo marketplace offers a wide variety of systems ranging from fairly basic, to a dizzying array of technical sophistication. Each has their place, form, and function. As illustrated in Figure 8-1, the type of handling system utilized is dependent to a large degree on the amount of cargo being handled and the speed at which it is being processed.

Figure 8-1 Determining Appropriate Handling Systems. (SOURCE: Lynxs Group.)



Most landside air cargo terminal systems are simply dock doors to allow surface transportation (mostly trucks) to deliver the goods to the building. Not all surface cargo goes through buildings however. Many shipments are "built up" (prepared to be placed in the aircraft, either inside containers/ULDs or as break-bulk) and delivered through the airport's airside security gates which allow trucking directly to the aircraft ramp, by passing the warehouse, where they are loaded onto the aircraft. But most shipments arrive through typical dock doors located along the landside of the cargo buildings. Again, some cargo has already been prepared off-site for shipment, while other cargo must be built up on site inside the cargo warehouse.

Manual Load Facilities **–** These are often, but not necessarily, low-volume terminals. Where manpower is both available and inexpensive, freight may be moved by manhandling over extensive layouts of roller beds and transfer tables. Use of fork lifts in these facilities is common. Racks may be used to store lose cargo but not ULDs. Such terminals are also desirable when there are problems with the supply of hard currency to purchase equipment and spares and where there is a lack of skilled labor for equipment maintenance.

Regional Integrator Sort and Load – Containers are moved by mobile lifting and transfer equipment, for example, forklift trucks. Conveyor systems and sortation platforms and slides may comprise the integrated express terminal interiors. ULDs may be stored on racks.

Figure 8-2 FedEx Express Sorting System. (SOURCE: Lynxs Group.)

Large Hubs or Gateways **–** Involving Transfer Vehicles (TVs) and Elevated Transfer Vehicles (ETVs), these facilities use single- or multiple-level storage of containers, which are moved within the terminal mainly by railed transfer vehicles. ETV operations produce high throughputs per square foot, with minimum container damage and minimum labor requirements. These facilities are very expensive to construct and operate and require a steady stream of demand for return on investment.

Figure 8-3 Elevating Transfer Vehicle (ETV) Systems. (SOURCE: Lynxs Group.)

Handling Systems

The cargo storage system (CSS) – is used for storing ULDs. Each cargo compartment can be designed for holding one or multiple standard IATA ULDs or pallets. Each compartment is provided with a roller deck on which the ULD moves. In the case of multiple ULDs stored in one compartment, the system ensures that they do not collide. Two types of roller deck that are normally installed in the storage rack are powerless storage roller decks and passage motor-driven roller decks.

The powerless storage roller deck is driven by the ETV/stacker friction drive, which moves the ULD in or out of the storage deck. The ULDs are pushed onto or retrieved from the roller conveyor by these devices. Motor-driven roller conveyors are used on both the airside and landside, together with ETVs/stackers.

ETV – The ETV lifts and carries aircraft ULD containers between the floor level working and transfer environment and storage positions in the CSS structure above. ETVs work best in warehouses where the cargo arrives off trucks pre-packed in ULDs or on cookie sheet pallets.

TV/TS **–** Transfer Vehicles and Transfer Shuttles are the traditional rail mounted prime movers within the floor level ULD storage and transfer systems of large airport cargo terminals. Transfer Vehicles are operated by an onboard driver while Transfer Shuttles are driven remotely by an operator or automated control system.

Ball Decks – provide a multi-directional transfer medium to allow staff to manually manoeuver, redirect and reorient ULDs. Small deck areas may be installed as junctions between conveyors and other equipment, while in more extensive installations large Ball Decks act as prime mover, used to manually transfer and manipulate ULDs between arrays of interfacing equipment.

Castor Decks – provide a high performance alternative suitable for lighter weight ULDs typical of express operations. Castor Decks fully encapsulate the castors with treaded walkway plate, providing a safe surface on which staff can manipulate the containers.

Nose Dock – nose-dock loading systems allow nose-loading aircraft (i.e. B747) to load directly from the ETV system through the open nose of the aircraft, which is parked immediately adjacent to the system within the cargo terminal building.

Cargo terminal buildings supporting CSS vertical storage systems have ceiling heights up to 35 to 40 high depending on roof trusses and fire sprinkler systems. Cargo terminal warehouses for airports supporting largely domestic cargo activity typically have ceiling heights ranging 20 to 23 feet in height. Building heights need to be taken into consideration by airport planners, since higher structures typically need to be set further back from runways to avoid penetrating the airport's controlled airspace.

EFFECTS: GROUND SERVICE EQUIPMENT (GSE) OPERATING SPACE

The same basic functions driving the shift in warehouse utilization have similarly affected Ground Service Equipment (GSE) space. Curiously, any efficiency gain has only been acknowledged on a theoretical basis while neither carriers, nor handlers nor developers indicated that such efficiencies have been entered into facilities planning. While the use of third party handling should facilitate greater utilization of GSE equipment and space as shifts and labor have been expanded, GSE planning seems to have been more tied to aircraft utilization and ramp operations than to warehouse operations.

EFFECTS: AIRCRAFT PARKING RAMP

Older versions of air cargo planning documents often made algorithmic associations between warehouse and ramp size on the basis of the payload capacity of aircraft. While still an intuitively logical approach, it requires considerable more nuance than such a simplistic computation may suggest.

The freighter fleet itself has changed dramatically since older methodologies were created, although smaller "spoke" markets may have been left largely unaffected as Cessna Caravan feeder aircraft flying one or two more daily operations would have less dramatic effects than large international gateways that may have planned for earlier versions of the Boeing 747 freighter fleet to be the permanent workhorse of the industry. While only applicable to transcontinental gateways for now, airports have been challenged to either build or expand apron to accommodate new larger freighters, often having to sacrifice the number of positions in the process.

While warehouse utilization can be raised by adding labor and automation, ramp is much less forgiving. Domestically, carriers have windows in order to meet the sortation operations at their regional and national hubs, so peak periods for aircraft on the ground tend to be bundled. Similarly, international carriers with transatlantic and transpacific operations will have their own windows, albeit possibly countercyclical to those of domestic operators (due to stage length and time zone differences).

Further complicating the planning issues, “partial freighters” have become a useful tool for airlines that may not have enough demand in individual U.S. markets to justify a transpacific flight but can improve payloads by allocating portions to multiple markets, such that a freighter may stop in Atlanta and Dallas/Ft. Worth prior to refueling in Anchorage and returning to Asia. On a theoretical basis, warehouse demand should only be affected by the amount of payload dedicated to the local market. While it is also possible that the aircraft may be unloaded and loaded more quickly when only a portion is to be handled in a market, there is no similar effect on the ramp size required, which must be large enough to accommodate the largest freighter that will use it.

At least for near to mid-term planning, flight schedules are critically important tools for ramp planning. While schedules are fluid and often seasonal, a single ramp position can be reused multiple times per day if schedules permit. For carriers and handlers, this is also true for labor and GSE equipment utilization. As an example, a gateway that is almost exclusively a transatlantic or transpacific gateway (one or the other) may anticipate lower utilization rates for ramp space as carriers will tend to require the same operating windows. Gateways with a healthy mix of transatlantic and transpacific freighters may be more able to reuse ramp positions. Gateways with multiple daily operations by a single international carrier will also tend to be able to reuse positions as the carrier typically is trying to meet multiple windows in its own schedules and will attempt to not have redundant flights on the ground. However gateways at which an international carrier may have both passenger and freighter flights could easily have both all-cargo and belly cargo throughput in the warehouse concurrently.

While much of the preceding focused on international gateways, domestic cargo hub and spoke cities must also pay no attention to integrator fleets and schedules. Declarations in late 2012 by FedEx signaled an intention to potentially fly larger domestic freighters but fewer frequencies and possibly fewer destinations served by air. Trucking would continue to be the beneficiary in terms of shares of domestic cargo transported by all modes. Some industry observers anticipate that UPS would likely follow suit.

Therefore, U.S. airports should be prepared for the possibility that larger ramp positions may be required in the near to mid-term OR alternatively that need could be diminished depending on whether the market is a beneficiary or victim of the trend. Either way, the dominant cargo carriers at the majority of U.S. commercial airports are in a prolonged period of operational transition and will require airports to remain flexible in their planning and development of air cargo facilities as both could emerge as a reality. As will be explored in the following sub-section, the effect of this trend has substantial implications not only for ramp but for airport land development in general.

EFFECTS: LAND

Previously it was noted that industry trends have left many legacy cargo facilities outdated to such an extent that airport operators must confront the possible reuse for non-cargo purposes or even demolition without near-term replacement. The industry has changed so dramatically that these facilities may simply no longer be necessary.

Moreover, airport operators must recognize that even for cargo carriers that have weathered the challenges of the last decade or so, the trend heavily in favor of trucking has diminished the need for on-airport locations. For decades, airports enjoyed a monopoly environment for cargo similar to that which they enjoyed for passenger operations with substantial premiums exacted simply because commercial operators had no choice but to locate on airport. Beginning in the 1990s, that compulsion for the carriers began to evaporate. UPS long favored a ramp presence that "outsized" its warehouse presence, preferring to perform as much sorting off-airport as possible. At international gateways, the decision by forwarders and others to locate near but off-airport was often simply a function of no land being available for new cargo facilities but even at land-rich domestic airports, the proliferation of "through-the-fence" operations by carriers like Airborne Express, Emery Worldwide and others grew as carriers found they could meet stem-times with substantial savings in warehouse lease costs a few miles from airports.

With domestic cargo and the domestic segments of international shipments increasingly being trucked, airport operators can no longer be satisfied that air cargo carriers have no choice but to locate on-airport. In many markets, airport operators must recognize that they compete with off-airport land options and give serious consideration to multi-tiered land valuations that recognize that reality. With third-party developers enduring long-term leases that may have been structured in far healthier times, airport operators may need to renegotiate escalation clauses and other lease terms that have left their provisional partners incapable of responding to off-airport competitive pressures without chronic losses.

Unless airport operators and their developer partners (where applicable) can produce a reliably competitive response, the alternative may be to start including non-airport assets in their capacity analyses, simply submitting to the reality that on-airport capacity no longer needs to be the exclusive domain – for formal planning purposes – of an airport's air cargo operations. Continuing to include tonnage that is actually handled off-airport against exclusively on-airport warehouse space can only produce an illusory utilization rate. Again, while land-constrained legacy hubs and international gateways may necessarily rely upon near-airport supplemental capacity to serve forwarders and other air cargo partners, land-rich airports that face prospective losses of air cargo tenants to off-airport locations must make a policy judgment about whether on-airport properties have been overvalued by traditional but no longer applicable market rationalizations.

AIR CARGO FACILITY REQUIREMENT RATIOS

The facility requirements element of the airport master plan summarizes a technical analysis of the aviation and allied facilities that will be required to accommodate the aeronautical activity (passenger, air cargo and general aviation/corporate) identified in the aviation forecasts element. During the airport master planning process, planners determine what, if any, additional facilities will be required to accommodate forecast activity. This task begins with an assessment of the ability of existing facilities to meet current and future demand. If they cannot, planners must determine what additional facilities will be needed to accommodate the unmet demand. This chapter is normally referred to as the facility requirements.

Air cargo warehouse, ramp, GSE storage and parking area data collected is used in this analysis to define planning metrics and ratios into functional relationships related to air cargo facilities. These ratios will provide airport planners using the Guidelines developed for this study a tool to compare utilization rates for their respective airport master plans with facility utilization ratios.

Building throughput rates are the standard measures to define the capacity of freight facilities, and this rate is expressed in square feet per annual ton of freight. Many master plans indicate that average building throughput rates at U.S. airports vary between 1.0 and 2.5 ft^2 per annual ton. A throughput rate of 1.0 ft^2 per annual ton typically indicates the facilities are well utilized and some near-term expansion may be required. The higher rate of 2.5 ft^2 per ton indicates existing tenants have ample – even surplus – space. These throughput rates, however, are all-inclusive and incorporate a wide variety of air cargo occupants such as passenger airlines, all-cargo carriers, integrated express carriers and third party providers. This analysis breaks out throughput ratios by air cargo carrier type and airport role; international gateway or domestic market. It is also important to point out that this analysis does not take into consideration air cargo that bypasses the cargo building and is trucked directly to aircraft on ramp as well as any cross docking operations taking place within the air cargo building.

Another method of determining air cargo warehouse area is to utilize a tonnage per area ratio (TAR). The TAR is defined in units of total annual tons of freight per square foot of cargo floor space. This ratio can then be compared to a derived maximum TAR value, which will typically range from 0.5 tons/square foot to 3.0 tons/square foot, with the latter being representative of a highly efficient automated sort operation. Achieving a higher value of TAR is dependent upon the degree of mechanization, the layout of the building, the type of cargo (international versus domestic; refrigerated, etc.) and on how the cargo is typically packaged for shipping (i.e. pallets, containers, etc.). For purposes of this analysis the team utilized the latter method, that being annual tons/square foot ratio which presents the less efficient facilities with a lower value.

AIR CARGO FACILITY REQUIREMENTS DATA COLLECTION ANALYSIS

Since this project focuses on air cargo facilities, specifically the development of new planning metrics in their design, survey tools were developed to gather information on the utilization and traffic flow related to on airport air cargo buildings. Three surveys were developed which included a survey of airport management and two surveys designed to gather information from private sector air cargo businesses. The three primary survey tools developed for ACRP 03-24 include an Airport Planners Survey, an Air Cargo Business Survey and the Air Forwarders Survey. Subtask 3.1 discussed the survey tool design and implementation.

Airport Planning Department Survey – The Airport Planning Department Survey was developed by CDM Smith Team to provide data for on-airport cargo facilities, operations, and plans related to air cargo activity at case study airports as well as participating system airports. Although the survey was titled Airport Planning Department Survey, the study team understood that airport planners, properties managers, marketing staff and airport air cargo managers were all potential respondents and so the survey instrument was designed with this wider respondent audience in mind.

Air Cargo Business Survey – This survey instrument was developed to provide data on cargo activity, on-airport cargo facilities, operations, and plans related to air cargo activity at case study airports as well as participating system airports. The survey was designed to be completed by a wide range of cargo operators on an airport such as passenger airlines, integrated express (FedEx, UPS, DHL, etc.,), cargo-only carrier/freighter, air freight forwarder, 3PL providers, regional air cargo carrier (Contractor) and ground handlers. The survey was sent or hand delivered to 174 air cargo business tenants via email and regular mail. Business lists were supplied by case study airports and non-case study airports. A response rate of 18% was achieved for this survey effort as a result of 31 responses being returned. The Air Cargo Business Survey was a self-completed survey that was emailed, mailed or handed out, completed by the respondent, then returned, either in person or by email.

Air Cargo Facility Utilization Data

A total of 31 airports responded to the Airport Planning Department Survey with 16 being the case study airports. The research team designed and implemented the Airport Planning Department Survey to collect air cargo data not only from case study airports but airports in the U.S. with scheduled air cargo service. This survey effort was system wide gathering data from Airport Council International (ACI) member airports which represent a wide range of airports in size and characteristics such as international gateway and major hub airports as well as O&D airports. The survey and data gap analysis collected cargo facility information for approximately 400 assigned air cargo building “bays” including warehouses with a single tenant. Analysis indicates that total space for all facilities analyzed is approximately 28.8 million square feet as presented in Table 8-1. These include small cargo bays in a cargo warehouse to complete cargo hub and sorting facilities owned and operated by integrators FedEx and UPS. Integrated express operator space comprised over 60% of all cargo warehouse space data gathered followed by 13% of the space attributed to passenger carrier cargo belly warehouse space. It is noteworthy to point out that there are a wide range of cargo warehouse occupant types located in “cargo warehouses” these include aircraft maintenance facilities, airline support businesses, and government agencies and airport maintenance activities as well as non-aviation businesses such as retail activity and a storage facility for an NFL team.

Table 8-1 Air Cargo Warehouse Space Collected and Analyzed.

Building Occupant Type	Number	Square Footage	Percent
Integrated Express	69	18,062,663	62.7%
Passenger Carrier-Belly Cargo	88	3,632,990	12.6%
U.S. Mail and Support	9	2,515,468	8.7%
Third Party Cargo Handers	62	1,663,062	5.8%
All Cargo Freighters	11	804,208	2.8%
Air Forwarders	36	511,879	1.8%
Vacant	32	368,898	1.3%
Airline Support	7	363,637	1.3%
Government	24	213,335	0.7%
Logistics Providers	10	185,987	0.6%
Miscellaneous	18	170,127	0.6%
Aircraft Maintenance	9	154,303	0.5%
Limousines	2	31,477	0.1%
Ground Support Businesses	6	31,475	0.1%
Aircraft Fuel Support	5	23,038	0.1%
Unknown	6	21,251	0.1%
Retail	1	17,439	0.1%
Deicing Support	1	6,681	0.0%
Total	**396**	**28,777,918**	**100%**

SOURCE: CDM Smith

Warehouse Throughput Analysis

Air cargo facility utilization data for the 31 airports analyzed in this study estimates annual ton per square footage utilization of air cargo for warehouse space. The analysis also provides annual ton per square footage utilization for ramp space, and GSE storage space. Truck and automobile parking facility development is based on warehouse size. Table 8-2 provides a facility requirements data matrix of ratios for the following:

- Warehouse space
- Ramp Area
- GSE Storage
- Truck/Auto Parking

The matrix also provides these ratios by cargo operator type, these include:

- Integrated express carriers
- Passenger carriers (belly cargo)
- Third party providers/All cargo carriers

As indicated in the matrix air cargo warehouse space ratios for integrated express carriers operating at domestic airports arrives at 0.92 annual tons per square foot while at international gateway airports it arrives at 0.37 annual tons per square foot. These values are based on weighted averages and are explained in greater detail in a forthcoming section. It is important to point out that as much as 20% of the freight moving through a cargo facility can be truck-to-truck, meaning that even though it is shipped on an airbill; it never gets on an airplane (PANYNJ, 2013). Much of this data goes unreported to the airport since it is not enplaned onto aircraft and can complicate the planning process. The airport planner should be mindful of this when collecting data from air cargo tenants and preparing ratios for facility development.

Passenger carriers tend to require more space than integrated express carriers due to the fact that they typically have less automation in the sorting process than the integrated express firms. Survey results for the passenger carriers for warehouses supporting domestic cargo activity indicate passenger carriers average 0.22 annual tons per square foot. While this ratio is accurate in presenting current ratios based on survey data it was deemed to be too inefficient (too much surplus space) by the CDM Smith Team since the data was collected during a period of passenger carrier declines in air cargo volume. A more suitable ratio for passenger carrier was ascertained by analyzing previous master plans conducted during the literature review task. It was found that when averaging the master plan ratios used for cargo warehouse facility requirements a ratio of 0.63 tons/sf is arrived at. Interestingly, cargo warehouse ratios for Miami International Airport network of warehouses also arrives at 0.63 tons/sf but the new Centurion air cargo facility just completed at the airport has a capacity of 1.25 tons/square foot. The Centurion cargo center provides 400,000 ft^2 of cargo space, 90 truck doors, 99,250 ft^2 of office space, and over 500,000 ft^2 of exclusive ramp space for nine wide body full freighters. The facility is subdivided in two spaces for perishable cargo (primarily flower and seafood imports in a temperature controlled environment), 140,000 ft^2, and space for general cargo, 260,000 ft^2.[2.]

Table 8-2 Air Cargo Facility Requirements Ratio Matrix.

	Integrated Express	Pax Belly	Third Party Providers & All Cargo Carriers
Warehouse			
Domestic	0.92	0.22	0.81
International Gateway	0.37	0.33	0.81
Master Plan Review Ratios	0.93	0.63	0.57
Ramp			
Domestic	0.19		0.16
International Gateway	0.19		0.91
GSE Storage			
General	0.57	0.36	1.11

SOURCE: CDM Smith.

Ramp space utilization based on annual cargo tonnage throughput arrives at approximately 0.19 annual tons per square foot for domestic cargo for integrated express carriers and 0.19 for the same carrier type at international gateway airports. For passenger carriers there is no need for cargo ramp facility requirements since cargo is loaded on the passenger terminal ramp away from cargo warehouses. Ratios for ground service equipment, or GSE, is typically not broken out in a master plan facility requirements. Cargo ramp or apron facility requirements in a typical master plan combine aircraft parking ramp areas and GSE storage areas. Since the data collection effort focused on data related to GSE spatial needs this analysis provides GSE space ratios for integrated express, passenger carrier and third party/all-cargo carriers. A detailed presentation on the facility requirements ratios for each type of cargo business analyzed is forthcoming.

Master Plan Review Results

A review and analysis of 12 airport master plans completed between 2005 and 2011 was conducted to identify recent innovative trends in air cargo facility master planning (Table 8-3 and Table 8-4). The literature review focused on four components of the air cargo master planning process: air cargo volume forecasts, air cargo aircraft operations forecasts, facility requirements, and recommendations. Notably missing from the airport master plans were innovative methods used to estimate future air cargo facility requirements. Facility requirements were calculated through the application of planning factors based on widely-used industry standards or local conditions. Seventy percent of these master plans facility requirements relied on warehouse space calculations using an annual ton per square foot ratio while the remaining used a square foot per annual ton ratio. For this analysis square feet per annual ton presented in several master plans were converted to tons per square feet.

Tables 8-3 and 8-4 provide analysis of 12 air cargo master plan facility requirements for air cargo warehouse space. Warehouse space was generally categorized to include all types of cargo carriers. A few master plans (DFW, SAT) broke air cargo warehouse ratios out for integrated express carriers, passenger carriers and for international gateways. Analysis also indicates that many master plans identified the current utilization rate then presented an air cargo warehouse facility planning ratio to apply to forecasted cargo tonnages. Details for the each of these airport's master plans is presented in Chapter 2 of this study.

Table 8-3 Facility Requirement Ratios Based on Master Plan Review.

Warehouse Space Ratios				**Domestic**		**Int'l Gateway**	
Airport	**ACI Cargo Volume Rank 2011**		**Cargo Activity**	**Cargo Building Ratio: Existing Warehouse Annual Ton/SF**	**Cargo Building Ratio: Future Warehouse Annual Ton/SF**	**Cargo Building Ratio: Existing Warehouse Annual Ton/SF**	**Cargo Building Ratio: Future Warehouse Annual Ton/SF**
Boise Airport, BOI	74		Non hub	0.63	1.52	n/ a	n/ a
Capital Region International Airport, LAN	94		Non hub	1.6	2	n/ a	n/ a
Cincinnati/ Northern Kentucky International Airport, CVG	17		Non hub (at time of analysis)	1.0	1.0	n/ a	n/ a
Dallas/Fort Worth International Airport, DFW	11		Hub	0.1	0.66	0.50	0.57
Dona Ana County Airport, 5T6	NA		Non hub	n/ a	1	n/ a	n/ a
George Bush Intercontinental Airport, IAH	15		Gateway	n/ a	0.66	n/ a	n/ a
Kansas City International Airport, MCI	45		Non hub	0.7	1.0	n/ a	n/ a
Memphis International Airport, MEM	1		Hub	n/ a	1.25	n/ a	n/ a
Oakland International Airport, OAK	12		Hub	n/ a	n/ a	n/ a	n/ a
Piedmont Triad International Airport, GSO	46		Hub	n/ a	n/ a	n/ a	n/ a
Portland International Airport, PDX	28		Gateway	0.42	0.66	n/ a	n/ a
San Antonio International Airport, SAT	33		Non hub	0.37	1.18	n/ a	n/ a
Average				**0.69**	**1.37**	**0.50**	**0.57**

Table 8-3 (continued) **Facility Requirement Ratios Based on Master Plan Review.**

Warehouse Space Ratios			**Domestic**		**Domestic**	
Airport	**ACI Cargo Volume Rank 2011**	**Cargo Activity**	**Integrators Building Ratio: Existing Warehouse Annual Ton/SF**	**Integrators Building Ratio: Future Warehouse Annual Ton/SF**	**Pax Belly Building Ratio: Existing Warehouse Annual Ton/SF**	**Pax Belly Building Ratio: Future Warehouse Annual Ton/SF**
Boise Airport, BOI	74	Non hub	n/ a	n/ a	n/ a	n/ a
Capital Region International Airport, LAN	94	Non hub	n/ a	n/ a	n/ a	n/ a
Cincinnati/ Northern Kentucky International Airport, CVG	17	Non hub (at time of analysis)	n/ a	n/ a	n/ a	n/ a
Dallas/Fort Worth International Airport, DFW	11	Hub	0.64	1.125	0.445	0.57
Dona Ana County Airport, 5T6	NA	Non hub	n/ a	n/ a	n/ a	n/ a
George Bush Intercontinental Airport, IAH	15	Gateway	n/ a	n/ a	n/ a	2.0
Kansas City International Airport, MCI	45	Non hub	n/ a	n/ a	n/ a	n/ a
Memphis International Airport, MEM	1	Hub	n/ a	n/ a	n/ a	n/ a
Oakland International Airport, OAK	12	Hub	n/ a	n/ a	n/ a	n/ a
Piedmont Triad International Airport, GSO	46	Hub	n/ a	n/ a	n/ a	n/ a
Portland International Airport, PDX	28	Gateway	n/ a	n/ a	n/ a	n/ a
San Antonio International Airport, SAT	33	Non hub	1.26	0.75	0.4	0.75

SOURCE: Review of airport master plans by CDM Smith.

AIR CARGO FACILITY RATIO ANALYSIS: THIRD PARTY HANDLERS AND ALL-CARGO CARRIERS

User Description – Third party handlers commonly occupy cargo warehouse space and provide a variety of cargo related services to both passenger airlines and all-cargo carriers. Integrated express carriers utilize third party providers in limited markets but this is the exception since the express industry typically handles their own ground operations. According to the terms of their service agreements, third party handlers may provide cargo unloading and break down, cargo buildup and loading, cargo aircraft parking, pushback and towing, crew transportation, aircraft de-icing, weight and balance and aircraft load supervision, as well as documents handling for international shipments. All-cargo carriers operate airport-to-airport air cargo and freight services for their customers but do not offer passenger service. All-cargo carriers rely extensively on freight forwarders for trucking cargo between their warehouse on the airport and shippers located off-airport. These cargo providers may be located in a multi-tenant warehouse facility or they may occupy an entire cargo warehouse building.

Warehouse Space

Sample Size – Data related to facility use by third party handlers and all-cargo carriers is comprised of 71 survey responses related to warehouse space within the Airport Planners Survey; 33% are third party handlers and 66% are all-cargo carriers. Given the limited sample size of third party handlers, and, due to the similar nature of all-cargo carrier and third party provider activities on an airport, the two data sets were combined. Data related to warehouse space and annual cargo tonnage by entity was collected. However, while all provided warehouse square footage, not all respondents provided annual tonnage by occupant data. In the case of Third Party Handlers and All-cargo Carriers, annual tonnage data was only collected for 24 of the 71 occupants (34%).

Analysis indicates that 41 of the 71 third party handlers and all-cargo carrier warehouses are located on international gateway airports. The international gateway airport functions as a consolidation, distribution, and processing point for international air cargo. Case study airports in the database that are considered international gateway airports include: Atlanta (ATL), Dallas (DFW), Dulles (IAD) and Seattle-Tacoma (SEA) among others. The 41 third party handlers and all-cargo carrier warehouse facilities at international gateways where data was collected average 46,800 ft^2 in size. The 30 third party handler and all-cargo carrier warehouse facilities that support domestic cargo activity average 7,000 ft^2 in size, which is indicative of these facilities accommodating a smaller scale of operations and cargo volume. These averages may be used by airport planners for benchmarking purposes only but in no way should these average building sizes be used to determine facility requirements for their airport.

Warehouse Throughput Analysis – Analysis of third party handler and all-cargo carrier warehouse facility throughputs utilized a weighted average, straight or arithmetic average, as well as median analysis. Table 8-4 below identifies the throughput analysis and sample size for each grouping. The weighted average analysis related to Average Ton/Square Foot for third party handlers and all-cargo carriers located on both international gateway and domestic airports arrives at 0.81 annual tons per square foot while the straight average arrives at 0.58. The median throughput is approximately 0.70 annual tons per square foot. When analyzing just the third party handler and all-cargo carrier warehouse facilities located on international gateways the analysis results in a weighted average of 0.81 and straight average of 0.548. The median throughput is 0.94. When all the data, including outliers, are included the throughput ratios are skewed downward since most of the outliers are comprised of very large inefficiently used warehouses.

Table 8-4 Air Cargo Warehouse Throughput Rates for Third Party Handlers and All-Cargo Carriers.

	Annual Tons/SF	Median Annual Tons/SF	Straight Averaging Ratios	Sample Size
Average Ton/Square Foot	0.81	0.695	0.58	21
Average Ton/Square Foot – Intl	0.81	0.94	0.548	15
Average Ton/Square Foot with Outliers	0.76	0.62	0.32	24
Average Ton/Square Foot w/ Outliers – Domestic	0.55	0.507	0.32	9
Average Ton/Square Foot with Outliers – Intl	0.76	0.62	0.45	14

SOURCE: CDM Smith.

Ramp Space

Sample Size – A little more than half of the respondents answering questions on cargo warehouse space completed questions on ramp space. Data related to facility use by third party handlers and all-cargo carriers is comprised of 46 survey responses related to ramp space within the Airport Planners Survey; approximately 50% of respondents at domestic station airports do not lease ramp space since they tug cargo to awaiting aircraft at the passenger terminal ramp. Data related to ramp space and annual cargo tonnage by entity was collected. However, while all provided ramp square footage, not all respondents provided annual tonnage by occupant data. In the case of Third Party Handlers and All-cargo Carriers, annual tonnage data was only collected for 17 of the 46 occupants (37%).

Analysis indicates that 25 of the 46 third party handlers and all-cargo carrier ramps (54%) are located on international gateway airports. The 25 third party handlers and all-cargo carrier ramp facilities at international gateways where data was collected average 77,000 ft^2 in size. The 14 third party handler and all-cargo carrier ramp facilities that support domestic cargo activity average 18,000 ft^2 in size. It is noteworthy to point out that seven respondents (15%) indicated they had no ramp space whatsoever.

Ramp Throughput Analysis – Ramp throughput rates are the standard measures to define the capacity of freight facilities, and this rate is expressed in annual tons of freight per square foot of ramp space. Many master plans indicate that average ramp throughput rates at U.S. airports vary between 1.0 and 0.4 annual tons per square foot. A throughput rate of 1.0 annual ton per square foot typically indicates the facilities are well utilized and some near-term expansion may be required. These ratios however often include ramp utilized for both aircraft parking and GSE storage and operating space. Similar to warehouse cargo throughput ratios, these rates, however, are all-inclusive and incorporate a wide variety of air cargo occupants such as passenger airlines, all-cargo carriers, integrated express carriers and third party providers.

Table 8-5 below identifies the throughput analysis and sample size for each weighted average, straight or arithmetic grouping. The weighted average analysis related to Average Ton/Square Foot for third party handlers and all-cargo carriers located on both international gateway and domestic airports arrives at 0.78 annual tons per square foot while the straight average arrives at 0.25. The median throughput is 0.76 annual tons per square foot. When analyzing just the third party handler and all-cargo carrier ramp facilities located on international gateways the weighted average, straight average and median throughput all arrive at 0.92.

Table 8-5 Air Cargo Ramp Throughput Rates for Third Party Handlers and All-Cargo Carriers.

	Annual Tons/SF	Median Annual Tons/SF	Straight Averaging Ratios	Sample Size
Average Ton/Square Foot	0.78	0.76	0.25	17
Average Ton/Square Foot – Domestic	0.16	0.13	0.1	7
Average Ton/Square Foot – Intl	0.92	0.92	0.92	10

SOURCE: CDM Smith.

GSE Space

Sample Size – A little more than half of the respondents answering questions on cargo warehouse space completed questions on GSE space. Data related to facility use by third party handlers and all-cargo carriers is comprised of 47 survey responses related to GSE space within the Airport Planners Survey; approximately 30% of respondents at domestic station airports indicated that they do not lease GSE space or rolled GSE space into the ramp area response. Data related to GSE space and annual cargo tonnage by entity was collected. However, while all provided GSE square footage, not all respondents provided annual tonnage by occupant data. In the case of Third Party Handlers and All-cargo Carriers, annual tonnage data was only collected for 16 of the 47 occupants (34%).

Analysis indicates that 23 of the 47 third party handlers and all-cargo carrier GSE spaces are located on international gateway airports. The 23 third party handlers and all-cargo carrier ramp facilities at international gateways where data was collected average 47,000 ft^2 in size. The 14 third party handler and all-cargo carrier GSE facilities that support domestic cargo activity average 7,800 ft^2 in size. It is noteworthy to point out that 11 respondents (23%) indicated they had no ramp space whatsoever.

GSE Space Throughput Analysis – GSE space throughput rates are the standard measures to define the capacity of freight facilities, and this rate is expressed in annual tons of freight per square foot. Most airport master plans do not provide ratios for ramp space for aircraft parking and GSE storage requirements.

Table 8-6 below identifies the throughput analysis and sample size for just the weighted average analysis since the sample size is considerably small. The weighted average analysis related to Average Ton per Square Foot for third party handlers and all-cargo carriers located on both international gateway and domestic airports arrives at 1.12 annual tons per square foot while the straight average arrives at 0.35. The median throughput is 0.81 annual tons per square foot.

Table 8-6 Air Cargo GSE Space Throughput Rates for Third Party Handlers and All-Cargo Carriers.

	Annual Tons/FT	Median Annual Tons/FT	Straight Averaging Ratios	Sample Size
Average Ton/Square Foot	1.12	0.81	0.35	13

SOURCE: CDM Smith.

AIR CARGO FACILITY RATIO ANALYSIS: INTEGRATED EXPRESS CARRIERS

User Description – Integrated express carriers commonly occupy cargo warehouse space on airports and utilize ramp area for parking aircraft and storing ground service equipment. FedEx Express and UPS are the dominant carriers in the U.S. that fall into the integrated express carrier category but they each have unique attributes related to their on airport operations. FedEx Express began as a cargo airline utilizing a hub and spoke system of aircraft routes. The spoke stations were often located on airports but over time some stations have expanded to off-airport facilities. Many stations were originally built by FedEx on leased airport land but today it is not uncommon for a FedEx Express station to be owned by a third party developer. UPS on the other hand originated as a trucking company moving parcels and packages and then developed its own overnight air cargo network. Since UPS had significant off-airport warehouse infrastructure much of the package sorting and consolidating takes place off-airport. As a result, UPS, in general, often occupies smaller airport cargo warehouse space than FedEx Express. DHL also operates with a minimal foot print on airports since they too rely heavily on off-airport warehouse facilities for sorting and consolidation. DHL has focused on international inbound and outbound express packages and has a small market share in the U.S. It is noteworthy to point out that integrated express carriers utilize third party handlers in some markets. For example, UPS ground operations at Dulles in Washington DC are handled by Swissport staff for aircraft loading and unloading whereas the entire UPS operation at Rickenbacker International Airport in Columbus Ohio is entirely handled by UPS staff.

Warehouse Space

Sample Size – Data related to facility use by integrated express carriers is comprised of 63 survey responses related to warehouse space within the Airport Planners Survey. Annual tonnage data was only collected for 43 of the 63 occupants (68%). Analysis indicates that the 63 integrated express carrier warehouse facilities at domestic cargo stations average 29,100 ft^2 in size. On a related note integrated express stations on international gateway airports average 81,200 ft^2 in size (based on a sample size of 17 respondents).

Warehouse Throughput Analysis – Table 8-7 below identifies the throughput analysis and sample size for each weighted average, straight or arithmetic average, as well as median grouping. The weighted average analysis related to Average Ton/Square Foot for integrated express carriers located on both international gateway and domestic airports arrives at 0.81 annual tons per square foot while the straight average arrives at 0.83. The median throughput is 0.81 annual tons per square foot. When all the data, including outliers, are included the throughput ratios are skewed upward since most of the outliers are comprised of very large inefficiently used warehouses. For example, one carrier in San Antonio International operates a Cessna 208 Caravan, carrying a mere 1,000 tons annually while utilizing a 23,700 ft^2 warehouse resulting in a utilization ratio of .043. At the same airport another integrated express carrier transported 65,755 annual tons and only utilized 7,000 ft^2 of space resulting in a ratio of 9.0. This carrier takes advantage of the temperate climate and conducts most of its package sort operations outside on the ramp. It is also important to point out that this analysis does not take into consideration air cargo that bypasses the cargo building and is trucked directly to aircraft on ramp as well as any cross docking operations taking place within the air cargo building.

Table 8-7 Air Cargo Warehouse Throughput Rates for Integrated Express Carriers.

	Annual Tons/SF	Median Annual Tons/SF	Straight Averaging Ratios	Sample Size
Average Ton/Square Foot with Outliers – Domestic	0.56	0.85	0.6	43
Average Ton/Square Foot – Domestic	0.81	0.85	.83	36
Average Ton/Square Foot – International	0.36	0.38	0.40	15

SOURCE: CDM Smith.

Ramp Space

Sample Size – Nearly all of the respondents answering questions on integrated express cargo warehouse space completed questions on ramp space. Data related to facility use by integrated express carriers is comprised of 78 survey responses related to ramp space within the Airport Planners Survey. Annual tonnage data was only collected for 41 of the 78 occupants (53%).

Analysis indicates that nine (non-hub) of the 41 integrated express carrier ramps are located on international gateway airports. The international gateway airport functions as a consolidation, distribution, and processing point for international air cargo. The nine integrated express carrier ramp facilities at international gateways where data was collected average 305,000 ft^2 in size or 7 acres. The 32 integrated express carrier ramp facilities at domestic airports where data was collected average 138,000 ft^2 in size or 3.2 acres.

Ramp Throughput Analysis – Ramp throughput rates are the standard measures to define the capacity of freight facilities, and this rate is expressed in annual ton of freight per square foot of ramp. Airport master plans use several methods for determining ramp space. For example, in the San Diego International Airport Master Plan, one accepted planning criterion for cargo apron is to allow five ft^2 of apron per square foot of cargo building space. Another method is to utilize an average area per aircraft based on the fleet mix in the master plan cargo forecast. These parking areas incorporate standard wingtip clearances and allow room for GSE, as well as room for a taxi-lane to service the area. Both these ratios however often include ramp utilized for both aircraft parking and GSE storage and operating space. Our proposed method for determining the spatial needs of integrated express cargo ramp are is similar to integrated warehouse cargo throughput ratios, utilizing annual tons to square feet ratios.

Table 8-8 below identifies the throughput analysis and sample size for each weighted average, straight or arithmetic average, and median grouping. The weighted average analysis related to Average Ton/Square Foot for integrated express carriers located on both international gateway and domestic airports arrives at 0.21 annual tons per square foot while the straight average arrives at 0.18. The median throughput is 0.22 annual tons per square foot. When analyzing just the integrated express carrier ramp facilities located on international gateways the analysis results in a weighted average of 0.19 and straight average of 0.14. The median throughput arrives at 0.25.

Table 8-8 Air Cargo Ramp Throughput Rates for Integrated Express Carriers.

	Annual Tons/FT	Median Annual Tons/FT	Straight Averaging Ratios	Sample Size
Average Ton/Square Foot	0.21	0.22	0.18	41
Average Ton/Square Foot – Domestic	0.19	0.2	0.17	33
Average Ton/Square Foot – Int'l	0.19	0.25	0.14	15

SOURCE: CDM Smith.

GSE Space

Sample Size – A little more than half of the respondents answering questions on cargo warehouse space completed questions on GSE space. Data related to facility use by integrated express carriers is comprised of 45 survey responses (56%) related to GSE space within the Airport Planners Survey.

GSE Space Throughput Analysis – Analysis of third party handler and all-cargo carrier GSE area throughputs utilized a weighted average, straight or arithmetic average, as well as median analysis. Table 8-9 below identifies the throughput analysis and sample size for just one grouping since the sample size is considerably small. The weighted average analysis related to Average Ton per Square Foot for integrated express carriers located on both international gateway and domestic airports arrives at 0.57 annual ton per square feet while the straight average arrives at 0.25. The median throughput is 0.43 annual ton per square feet.

Table 8-9 Air Cargo GSE Space Throughput Rates for Integrated Express Carriers.

	Annual Tons/FT	Median Tons/FT	Straight Averaging Ratios	Sample Size
Average Ton/Square Foot with Outliers	0.56	0.53	0.35	45
Average Ton/Square Foot	0.57	0.43	0.25	31

SOURCE: CDM Smith.

AIR CARGO FACILITY RATIO ANALYSIS: PASSENGER CARRIERS

User Description – Passenger airlines commonly occupy cargo warehouse space within an airport's designated cargo area. Passenger airlines offering cargo service may be located in a multi-tenant warehouse facility or they may occupy an entire cargo warehouse building. Some passenger carriers operate only narrow-body and regional jet aircraft and are thereby limited in the size of air cargo they are able to carry in the belly compartment of the aircraft. Due to these gauge of aircraft, carriers manually bulk load cargo into these aircraft baggage compartments which is a time consuming and labor intensive activity. Many major airlines, on the other hand, operate wide-body aircraft which have the capability of utilizing lower deck ULD containers which expedites the loading and unloading of cargo into belly compartments. Aircraft gauge often impacts the size of air cargo warehouse space needed to accommodate the carrier's cargo traffic. Wide-body aircraft rely on more GSE equipment such as K loaders and dolly carts to transport and lift cargo containers into the aircraft. This activity and equipment typically results in the need for more GSE space than airlines operating narrow-body passenger aircraft.

Warehouse Space

Sample Size – Data related to facility use by passenger carriers is comprised of 91 survey responses related to warehouse space within the Airport Planners Survey; 50% are located on international airports and 50% are located on domestic station airports. Annual tonnage data was collected for 50 of the 91 occupants (54%). Analysis indicates that 45 of the 91 passenger carrier warehouses are located on international gateway airports. The 45 passenger carrier warehouse facilities at international gateways where data was collected average 63,300 ft^2 in size while the 46 passenger carrier warehouse facilities that support domestic cargo activity average 14,900 ft^2 in size.

Warehouse Throughput Analysis – Table 8-10 below identifies the throughput analysis and sample size for each weighted average, straight or median grouping. The weighted average analysis related to annual tons per square foot for passenger carriers located on both international gateway and domestic airports arrives at 0.30 annual tons per square foot while the straight average arrives at 0.84. The median throughput is 0.13 annual tons per square. When analyzing just the passenger carrier warehouse facilities located on international gateways the analysis results in a weighted average of 0.33 and straight average of .156. The median throughput is 0.19.

Table 8-10 Air Cargo Warehouse Throughput Rates for Passenger Carriers.

	Annual Tons/SF	Median Annual Ton/SF	Straight Averaging Ratios	Sample Size
Average Ton/Square Foot	0.3	0.13	0.84	44
Average Ton/Square Foot – Domestic	0.18	0.1	0.065	24
Average Ton/Square Foot – Intl	0.33	0.19	0.156	18
Average Ton/Square Foot with Outliers	0.32	0.13	0.067	50
Average Ton/Square Foot with Outliers – Domestic	0.21	0.1	0.064	27
Average Ton/Square Foot with Outliers – Intl	0.32	0.19	0.077	22

SOURCE: CDM Smith.

Ramp Space

Dedicated cargo ramp space for passenger carriers was not analyzed since most passenger carrier facilities do not have a need for designated air cargo ramp area to park aircraft since cargo for passenger carriers is typically tugged to the aircraft parked at the passenger terminal ramp. There are a few exceptions to this rule such as Alaska Airlines which has aircraft ramp adjacent to their warehouse in SEA which supports its fleet of three B737 convertible cargo/passenger aircraft. Additionally, Delta Air Lines at the same airport inherited a B747 ramp when they merged with Northwest Airlines. Its noteworthy to point out that it is not unusual for airlines to adapt to cargo facilities they inherit from other carriers. For example at Rickenbacker International FedEx operates at a facility they inherited from Flying Tigers as part of their acquisition of the carrier in the late 1980s. This 275,000 facility is too large for FedEx Express operations so they share about half of the building with FedEx Ground which is very much outside the norm for their system.

GSE Space

Sample Size – A little more than half of the respondents answering questions on cargo warehouse space completed questions on GSE space. Data related to facility use by passenger carriers is comprised of 57 survey responses related to GSE space within the Airport Planners Survey. Annual tonnage data was only collected for 19 of the 57 occupants (33%). Analysis indicates that 23 of the 57 passenger carrier GSE spaces are located on international gateway airports. The 23 passenger carrier ramp facilities at international gateways where data was collected average 94,500 ft^2 in size. The 34 passenger carrier GSE facilities that support domestic cargo activity average 17,500 ft^2 in size.

GSE Space Throughput Analysis – GSE space throughput rates are the standard measures to define the capacity of freight facilities, and this rate is expressed in annual ton of freight per square foot. Most airport master plans do not provide ratios for ramp space for passenger airlines GSE storage requirements.

Analysis of third party handler and all-cargo carrier GSE area throughputs utilized a weighted average, straight or arithmetic average, as well as median analysis. Table 8-11 below identifies the throughput analysis and sample size for just one grouping since the sample size is considerably small. The weighted average analysis related to Average Ton per Square Foot for passenger carriers located on both international gateway and domestic airports arrives at 0.36 annual tons per square foot while the straight average arrives at 0.25. The median throughput is also 0.25 annual tons per square foot.

Table 8-11 Air Cargo GSE Space Throughput Rates for Passenger Carriers.

	Annual Tons/SF	Median Annual Tons/SF	Straight Averaging Ratios	Sample Size
Average Ton/Square Foot	0.36	0.25	0.25	19

SOURCE: CDM Smith.

AIR CARGO WAREHOUSE TRUCK DOOR AND DOCK RATIOS

Truck doors and truck docks function as primary transfer points from vehicles to the air cargo warehouse. A cargo warehouse is typically comprised of truck docks and doors on the landside portion of the building. On the airside of the building where tugs and other vehicles have direct access the ramp and GSE area a cargo warehouse will have truck doors only. The Airport Planner Survey collected data on the number of truck doors and docks for air cargo buildings as well as square footage of these buildings. Data for 91 air cargo warehouses was analyzed to determine the door to square feet ratio. As shown in Table 8-12, there are 36 warehouse buildings with less than 50,000 ft^2 of space. When dividing the square footage by the number of truck doors and docks the average square footage to door ratio is derived. For these smaller cargo buildings there is one truck door/dock for every 1,500 ft^2 of space. Further analysis indicates that the larger the building the more square footage per door is required. Cargo warehouse buildings over 200,000 ft^2 in size average approximately 4,000 ft^2 per door/dock.

Table 8-12 Warehouse Square Feet to Dock/Door Ratios.

Warehouse Building Space	Square Feet to Dock/Door Ratio	Sample Size
Buildings <50,000 ft^2	1,500	36
Buildings 50,000 to 99,999 ft^2	2,400	35
Buildings 100,000 to 199,999 ft^2	2,900	15
Buildings >200,000 ft^2	4,000	5

SOURCE: CDM Smith

AIR CARGO WAREHOUSE TRUCK PARKING SPACE RATIOS

Warehouse development requires space for parking and maneuvering trucks on the landside area of air cargo buildings. Air Cargo warehouse parking areas typically experience a mix of uses such as employee parking and customer automobile parking in addition to truck parking. It is also noteworthy to point out that air cargo trucks range in size from commercial vans to tractor-trailers rigs with sleeper cabs and 53 foot-long trailers.

A review of airport master plans indicates there are a wide range of ratios used for estimating the amount of space needed for air cargo truck parking areas on airports including planning factors of 50% of the projected air cargo building space, and up to 3.5 ft^2 per square foot of warehouse space.

The Airport Planner Survey collected data on truck parking area related to air cargo buildings as well as square footage of these buildings. Data for 94 air cargo warehouse parking areas was analyzed to determine the truck parking to warehouse square feet ratio and is shown in Table 8-13. For example, there are 40 warehouse buildings with less than 50,000 ft^2 of space. The parking areas for these warehouse facilities equaled on average 120% of the existing air cargo building space. Further analysis indicates that the larger air cargo buildings utilized even less space per square foot of building space. Cargo truck parking space for warehouses greater than 200,000 ft^2 equals on average just under 90% of the existing air cargo building space.

Table 8-13 Air Cargo Warehouse to Truck Parking Ratio.

	Warehouse to Truck Parking Ratio	Sample Size
Buildings <50,000 ft^2	1.2	40
Buildings 50,000 to 99,999 ft^2	1.1	32
Buildings 100,000 to 199,999 ft^2	0.8	14
Buildings >200,000 ft^2	0.9	8

SOURCE: CDM Smith.

During interviews with a number of multipurpose building tenants at the Indianapolis International Airport it was stated that the truck parking area was inadequate. Interestingly, this facility to truck parking ratio is 1.5 (40,000 ft^2 warehouse and 60,000 ft^2 parking area). One of the main reasons for the congested parking is the fact that 20% of the parking area is dedicated to automobile parking. Several tenants suggested expanding the parking area 30 feet toward the access road. This expansion would lead to a ratio of 1.8 to 2.0 for the truck parking area and would likely relieve the congestion.

SECURITY IMPACTS: FEDERAL POLICY EFFECT ON OPERATIONS

Comprising both the TSA and CBP, the U.S. Department of Homeland Security's air cargo security requirements are the product of risk-based assessments that have – to date – prioritized enhancements directed at belly cargo for screening purposes, while striving to secure the entire supply chain. Given that forwarders may tender cargo to both passenger and all-cargo airlines, many enhancements have been applied universally, regardless of emphasis.

The immediate effect on U.S. airports of 100% screening requirements for enplaned belly cargo (both wholly domestic shipments, as well as the domestic segments of international shipments) was to encourage internally at U.S. airlines and forwarders the use of trucking as a substitute for air transport. Because a host of economic influences converged simultaneously to decrease air cargo demand in the U.S., accurately isolating the sole effect of security requirements is unlikely but both forwarders and carriers have acknowledged an increased role of trucking cargo from feeder cities in order to leverage the larger volumes at international gateways to recover investments in equipment, trained labor and facilities in their gateways. These transfers of air cargo market share compounded the losses of the previous decade by pure belly carriers that had favored smaller (low cargo capacity) aircraft, as increased flight frequencies could not compensate for deficiencies that reduced time-sensitive air cargo shipments to break-bulk operations.

The implementation of the Certified Cargo Screening Program (CCSP) reduced the potential negative effect of bottlenecks at major gateways by allowing air cargo to be screened off-airport, as long as the "chain of custody" could be demonstrably preserved between screening and enplanement. The potential impact on cargo facilities' operating space was reduced commensurately, reducing what had been a grave concern that legacy cargo facilities – particularly those predominantly serving belly carriers – would have to be retrofitted to accommodate full payloads of cargo to be screened.

SECURITY IMPACTS: FACILITIES

Airside – Cargo facilities at some airports have been modified to establish dedicated lanes established for CCSP prescreened cargo. On the airside, such modifications are most noticeable in terms of directional signage at the ingress from roadways into parking lots, as well as above dedicated docks. The consultants have only observed such modifications at the cargo terminals of belly carriers in such major gateways as JFK and ORD. Apart from signage, no other tangible alterations have been observed on the airside of air cargo facilities.

Warehouse – Throughout interviews and surveys completed for this study, the consultants have been diligent in assuring cargo operators that no Security Sensitive Information (SSI) would be broached. Some elements have also proven so transient as to potentially compromise the longevity of utilization of this document by inclusion.

Perhaps the most critical unresolved element in terms of warehouse utilization and therefore planning is approved screening technology. Until air cargo operators are able to satisfactorily screen full pallets and containers, 100% screening of all air cargo (including freighter) would be so onerous as to inflict operational costs without guaranteeing a commensurate benefit. Many in the industry believe that given currently approved technology and the amount of air cargo shipments moving through the system daily, inspections would be so superficial to meet a 100% quota that air cargo security would not be enhanced. However if TSA should approve technology for scanning full pallets and containers, the prospective goal of 100% scanning of all shipments may come closer to reality.

To date, cargo security requirements have not had a demonstrable effect on airports' cargo warehouse capacity. Some have attributed this lack of negative impact on the overall drop in U.S. air cargo having created surplus facility capacity to absorb new spatial requirements. While details are still embargoed by TSA, early pilot programs tested at certain facilities did prove to be unwieldy in terms of spatial demand and disruptions but then the CCSP policy reduced the overall volume requiring screening. Modifications to facilities were also made in terms of layouts, learned from experience.

In the immediate aftermath of 9/11, many industry observers anticipated a bustling industry in third-party screening facilities that would consolidate an airports' screening functions into freestanding stations at which trucks would deliver consignments for screening before being taken to the facilities of handlers or carriers. However, early attempts at 3rd party screening facilities as separate revenue centers never gained much traction and eventually most screening – even that of 3rd party operators – was integrated into existing facilities. While it has no material bearing on facilities planning, most carriers and handlers have outsourced the screening function to vendors who work alongside warehouse staff but whose specific function is cargo screening.

In terms of facilities design and layout, no clear consensus emerged from carrier interviews and surveys about an effect on capacity utilization. Airport planners' emphasis must remain on providing adequate space – whether raw land or finished warehouse – to accommodate forecasted growth but have virtually no design role in affecting how cargo carriers and/or handlers manage flows to efficiently screen cargo and to segregate screened and unscreened cargo for the sake of the "chain of custody.

AIRPORT FACILITY REQUIREMENTS: SUSTAINABILITY ISSUES

ACRP Synthesis of Airport Practice 10: Airport Sustainability Practices defines airport sustainability as “a broad term that encompasses a wide variety of practices applicable to the management of airports.” The synthesis refers to practices that ensure:

- Protection of the environment, including conservation of natural resources.
- Social progress that recognizes the needs of all stakeholders.
- Maintenance of high and stable levels of economic growth and employment.

These are often referred to as the “triple bottom line” of sustainability and focus on – Economic Growth, Social Responsibility and Environmental Stewardship. The tenets of the Triple Bottom Line are often incorporated into sustainability definitions and programs.

Airports using green building products does not necessarily mean that a structure is sustainable or energy efficient. If a building is designed to be energy efficient, it is not a given that it is designed for sustainability either. The best approach to sustainable architecture, which is also environmentally sensitive and reduces energy use over the life of the building, is to adopt a program designed to meet all three sustainability objectives.

The LEED (Leadership in Energy and Environmental Design) certification program was devised in 1994 by the United States Green Building Council (USGBC) to encourage sustainable practices in design and development by means of tools and criteria for performance measurement. It is a voluntary, market-driven building rating system based on existing technologies. The USGBC has established standards for new construction and major renovations to existing structures and their standards can be applied to many different project types including airports, schools, retail, homes and neighborhood development.

The USGBC's LEED certification program provides independent, third-party verification that a building was designed and built using strategies aimed at achieving high performance in the following key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality.

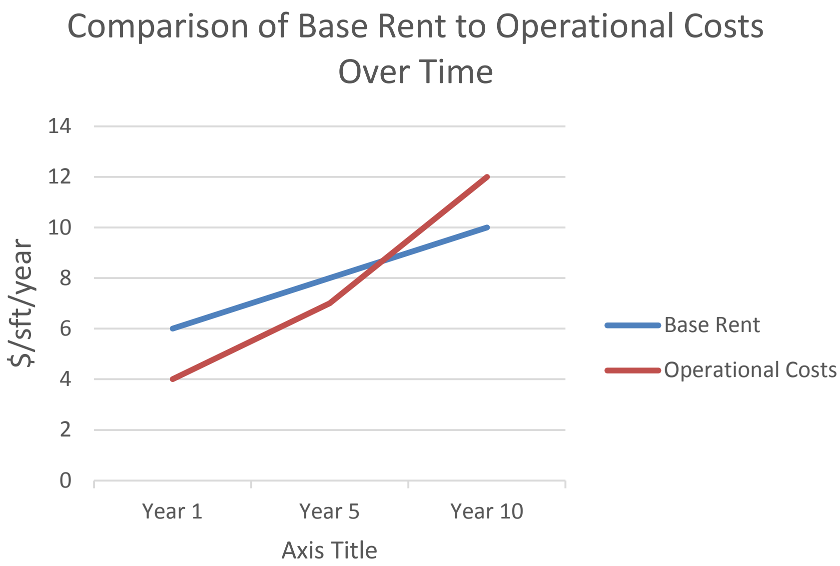
SUSTAINABLE CARGO FACILITIES

Like any other type of modern structure built in the past few years, air cargo facilities should be built and refurbished with sustainability at the forefront. Sustainability need not be considered a luxury, or even just a reaction to government regulation. It can also be viewed from the standpoint of economy, versatility and corporate image. Sustainable design can save the customer money, in terms of operating costs, maintenance, and usage. Sustainable buildings can often be more flexible, especially if there is an effort to define sustainability in terms of simplicity. Finally, sustainable structures can dovetail nicely into corporate image and culture, especially when carbon footprint and employee workplace conditions are considered.

Sustainable design need not cost more, although it most often does. Recent analysis shows that the "green premium" for buildings ranges from 1 to 7 percent. LEED-rated buildings came in at premiums of 1% for certified projects and 1.9%, 2.2% and 6.8% for Silver, Gold, or Platinum respectively. Design which leads to complicated structures do indeed add up to more construction costs. When the movement to add more sustainable features began in 2000 with the USGBC's LEED Certification program, contractors and developers automatically added one to 10% more to all costs. The trade off to the "green premium" was the upfront costs versus the ongoing sustainable operating cost savings. Payback periods of five to ten years, and even longer were common. However, the costs of sustainable features have come down dramatically, while the costs of utilities and other operating costs, have continued to rise. Paybacks are quicker as a result, and in some cases, such as LED lighting installation, cost vs. savings advantages can be dramatic.

One can see this trend clearly by examining the ratio of base rent to operating costs as illustrated in Figure 8-4. Ten years ago, operating costs, including all utilities, would often be less than 20% of the base rent of a building space (lease rate per square foot/meter, excluding any pass-through or extra operating costs). Today it is not uncommon to see operating costs at +50% of the base rent. In the future, one might find certain buildings wherein the operating costs are actually more than the base rent. Since base rent is the reflection of the actual cost to construct the building, and operating costs are mostly a reflection of a combination of the age and efficiency of the building plus the cost of operations including utilities, we can only assume that the base rent/operating costs ratios suggest the operating costs are rising faster than building costs. Therefore, sustainable features are increasingly a competitive economic advantage as well as a response to community standards.

Figure 8-4 Comparison of Base Rent to Operational Costs. (SOURCE: Lynxs Group.)



“Sustainability” is a broad and often politically charged term. If one cares only about compliance issues, then sustainability is whatever the building code says must be included in design and building standards. Generally, LEED Certification standards give guidance in this area, although local codes as well as airport requirements might have important variances. LEED Certification standards are well known, and there is a large community of consultants who will gladly lead any building design or refit project in the direction of LEED compliance. However, one can view sustainability as much more than compliance, as has been suggested above.

Sustainability issues related to airports should not only be associated with new construction, but also with sites which are being repurposed or rebuilt. With new projects, sustainable design is a given in most cases. However, the transformation of older, legacy sites becomes even more valuable if dynamic sustainable design and practices are incorporated into plans. Often structures are rebuilt to update the facility usage to more pressing current demands of an airport. Additionally, these updates should be considered as increasing the sustainability and efficiency of any airport site.

SUSTAINABLE AVIATION GUIDANCE ALLIANCE

An excellent compilation of sustainability issues and practices, specific to airports, can be found at http://www.airportsustainability.org/database#, published by the Sustainable Aviation Guidance Alliance (SAGA). A review of the major topics reveals how broad the field and definition of sustainability is. The SAGA Sustainability Spreadsheet of “Practices” contains over 850 distinct ideas for consideration. Appendix C provides a condensed version of the Sustainability Database Spreadsheet presenting only ideas for consideration that apply to Cargo/Warehousing & Freight Forwarding facilities. The database starts with administrative policies and procedures. One might not naturally think of administration as one of the hallmarks of sustainability, but a quick read indicates there are ample good ideas, easily implementable, which do not require significant capital expenditures. This area of sustainability revolves around foresight, good planning, a thoughtful implementation of sustainable standards at any location, and is eminently appropriate for cargo facilities at any airport. Moreover, this is one of the practice areas which is equally implementable in refurbishment/repurposed sites as well as newly constructed sites.

The SAGA database addresses more familiar sustainability subjects such as storm water management, water efficiency and landscaping. Practices in these areas are equally important in for both the construction and operational phases of the facility.

Ground transportation issues are discussed in great detail. While air cargo facilities are, by definition, intermodal, much of the operational sustainability of the site will happen landside. Heavy truck traffic and flowage as well as ground handling equipment usage is an obvious target. Less obvious might be public transportation access for employees, reducing the need for more employee automobile parking. This is a good example of multi-beneficial sustainability practices. Access to public transport not only helps the environment, benefits employees who wish to utilize it, but also makes more efficient use of the air cargo site, since the ratio of productive building usage to site size is increased.

Even though ground transportation can provide important sustainable benefits, building design and operations provide the best opportunity for sustainable benefits. LEED Certification standards are always a good start, but meant to provide guidance as much as be a target for compliance. Standard design features and fixes for sustainable buildings include:

- Wall and window insulation
- Cool roofs
- Efficient HVAC
- Efficient lighting including LED lights and skylights
- Good maintenance practices
- Rainwater recapturing
- Utilization of renewable energy sources
- Building orientation

These features may not only comply, but make the facilities better, more user-friendly and more valuable. The object is to ensure that sustainable buildings can be built and operated at competitive costs, rather than at a cost penalty. Recent advances in design and practice indicate we are headed in the right direction. For instance, the simple replacement a quantity of one hundred typical A-19 incandescent 60 watt bulbs with CFL 13 watt bulbs would cost about $80 more in total, but would yield a *yearly* operational savings of nearly $2,800/year. Five years ago purchase costs were way up and savings were not as dramatic; but now, the choice is clear and is as much about economics as about sustainability. Similar cost-to-savings ratios can be found in a variety of other areas such as water conservation, roofing and window treatments, as well as frequent maintenance routines. Even more savings can be gleaned from proper design features which influence efficiency, wherein the redesign might not actually cost anything, but the savings are real. In these cases, sustainable choices go right to one of the triple bottom line items: profitability.

Quality of life and workplace conditions are key sustainability features for any facility. Indoor environmental issues, daylight and views, and noise control should be addressed. In this respect, sustainability takes on not only the usual meaning, but also becomes about sustaining a quality, stable and happy workforce.

SUSTAINABILITY ISSUES RELATED TO AIR CARGO FACILITY LOCATION

One final sustainability issue should be considered primary: site selection. Air cargo facilities have often been built on parts of airports which may not be the most appropriate location or land use. This is particularly the case for many legacy air cargo sites which were built decades ago when the airport's traffic flow and air carrier needs were much different. A good example of this is a facility in which the truck court capacity is unable to accommodate larger modern tractor-trailers, leading to congestion and unnecessary engine idling. Additionally, some facilities do not have adequate airside cargo handling and GSE areas between the buildings and aircraft, or perhaps the aircraft ramp area is not appropriately sized to accommodate the aircraft using the cargo facilities today. This works both ways- some ramps are built for much larger aircraft than are being currently used, and some are built too small, particularly at gateway airports where modern freighters such as the 747-8 are considerably larger than their predecessors.

Many cargo areas are not appropriately located to interact with the forwarder and logistics community which are commonly located off airport. Proper cargo facilities should also be situated so that cargo related truck traffic does not have to mix with passenger traffic as this interaction slows down both vehicle types, is dangerous, and goes against the principles and practices of sustainability. If airports have inappropriate air cargo site locations in operation today, and thought is being given to making these sites more sustainable, one of the first questions airport planners should consider is if the site itself is sustainable. One factor for airport planners is to consider is air cargo related tug time and distance as well as ways to improve connectivity between the terminals and the cargo warehouses. New cargo areas on an airport can be costly, and relocating can be complicated and add to costs. But if better utilization of the current site by other uses is an option, starting anew at a new on-airport site is a viable option. If relocating cargo operations is not a viable, existing air cargo sites can still be improved in ways that can make a profound difference. New truck access entrances, new traffic flow patterns, better utilities, and different amenities can breathe new life into vintage sites, and form the basis of sustainable design and function for new sites. In any event, sustainability strategies start with the site location itself, and all efforts toward cargo facilities design and operation should use this as a foundation of their planning efforts.

SUMMARY

This chapter focused on techniques to develop planning metrics and functional relationships that enable a translation from forecasted demand to specific air cargo facility requirements, including elements in response to environmental, sustainability, and security concerns. The analysis describes the rationale behind the facility planning metrics. Additionally this chapter links industry trends with their effect on air cargo facilities planning metrics. The next chapter prepares a planning and development framework that is the basis for forming the Air Cargo Facilities Planning and Development Guidebook as well as the Air Cargo Facilities Planning Model.

CHAPTER 9: TASK 7—PLANNING AND DEVELOPMENT FRAMEWORK

INTRODUCTION

The cargo industry has changed significantly over the past twenty five years (1988–2013). As the world economy has become more global, markets and manufacturing has developed, shifted and in many instances relocated to markets with low labor rates. New logistics and supply chain concepts developed based on low fuel costs and labor costs along with trends in just-in-time production and final manufacturing assembly at destination. Short shelf life of new products increased during this time period and as the value of goods shipped has increased resulting in increases in the demand for expeditious transport and control as well as transparency. Domestic air cargo in the U.S. also experienced shifts particularly as fuel costs increased within the past five years and integrated express carriers developed deferred delivery business models reducing the demand for overnight delivery by aircraft and relying increasingly on truck networks.

THE ROLE OF THE AIRPORT IN AIR CARGO TRANSPORT

The air cargo terminal is a critical part in the air cargo supply chain. An inadequately sized air cargo warehouse that is unable to accommodate the peak volumes may result in shipment delays, while a cargo warehouse that is not designed with flexibility in mind to meet demand may become obsolete during its service life. Airports routinely accommodating air cargo operations typically have space dedicated to support this activity (Figure 9-1). The space is commonly comprised of aircraft parking apron, air cargo warehouses and truck parking and maneuvering areas. Cargo throughput between the land and air mode is either through the warehouse buildings or a through-the-fence security gate. These air cargo installations on airports function as a platform which allow for the interface between land and air modes with the goal of providing the expeditious processing of cargo. This platform has a role to play in ensuring that cargo products arrive at their destination on time and intact, that customers have easy access to the cargo facilities for collection and delivery, and that the truck access is relatively uncongested and does not interfere with passenger-related traffic. Cargo storage is an attribute of these facilities but the duration is by design to be limited. In a perfect world the cargo carrier would prefer that cargo arrive at the precise time for loading on to aircraft with no storage or processing time needed. Since there are typically numerous arrivals on cargo trucks to an air cargo terminal, space for processing, build up and storage is required. The space requirements vary from carrier type and size of the airports cargo market.

Air Cargo Process – Air freight is transported in dedicated cargo aircraft and in cargo space of passenger aircraft (belly cargo). Inbound belly cargo is unloaded and transported to cargo facilities or from one aircraft to another aircraft, while outbound belly cargo is transported from trucks to the cargo terminal and loaded onto the aircraft prior to departure. International cargo arriving as imports may have been precleared electronically or may be subject to additional inspection by regulators before being cleared to leave the airport. Similar to baggage handling, cargo on narrowbody and smaller aircraft is loaded individually while cargo on widebody aircraft is containerized. All large domestic air carriers report operating annual statistics to the U.S. DOT by filing “Form 41,” which includes information on revenue passenger miles, revenue ton miles, and fuel consumption.

Figure 9-1 shows trends during the 1990s in air freight revenue ton-miles by U.S. carriers (domestic and international service). In 1994, passenger and all cargo carriers handled approximately equal amounts of air freight. Since that time, air freight on all cargo aircraft has grown 64%, while air freight on passenger carriers has remained nearly constant. This is in part a reflection of the trend toward improving passenger load factors, changes in aircraft gauge of passenger airlines, and reductions in domestic wide-body aircraft lanes, which result in less capacity for freight. Looking at just domestic flights, air freight handled by passenger carriers declined 28% between 1994 and 2002 as freight and mail shifted to the integrated express carriers and the USPS relied less on passenger airlines and more on integrated express carriers to transport mail. While domestic cargo has been increasingly dominated by integrated carriers operating all-cargo aircraft, gateways serving transcontinental routes have recently experienced the opposite trend as more cargo-friendly passenger aircraft have taken market share from freighters.

Figure 9-1 Simple Air Cargo Area Diagram. (SOURCE: CDM Smith)

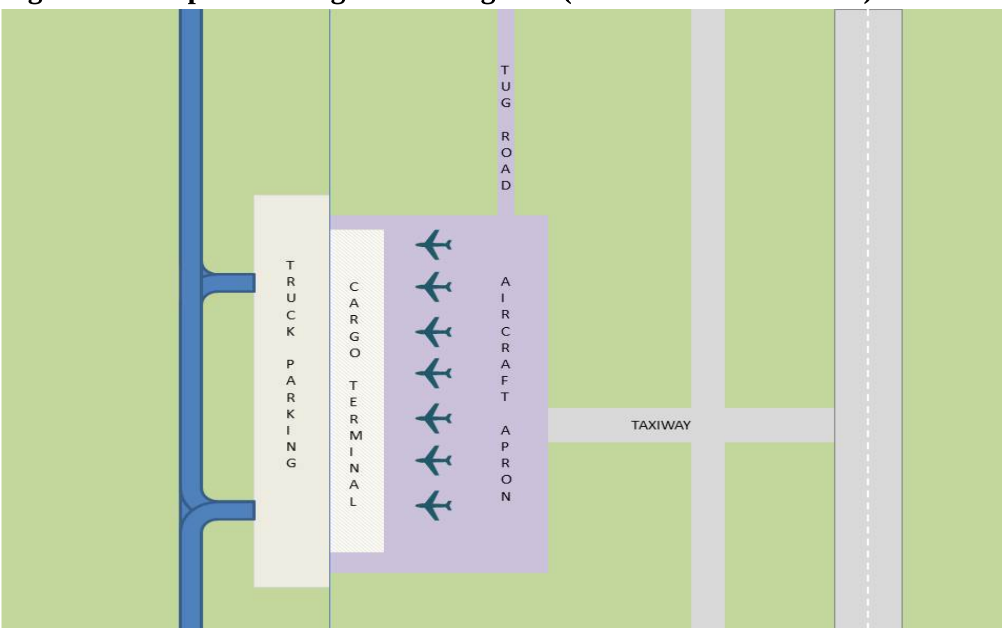
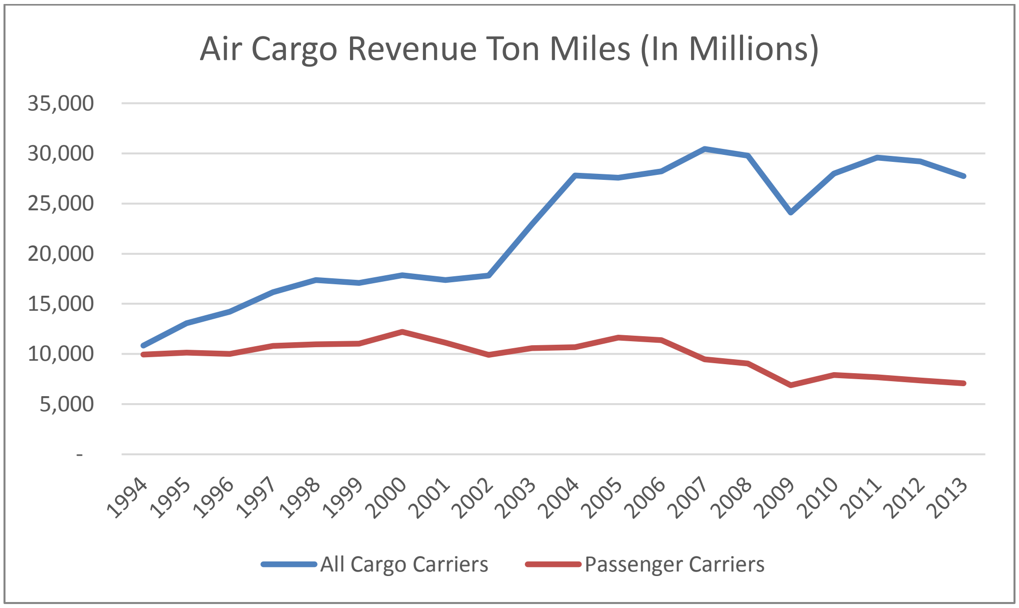


Figure 9-2 Air Freight Revenue Ton-Miles by Carrier Type, 1994 – 2002. (SOURCE: FAA Aerospace Forecasts. [Multiple Years])



EXISTING CONDITIONS

Many cargo buildings on airports today were constructed in an era which had many more passenger and air cargo airlines. Today the air cargo industry on the U.S. domestic front has four remaining legacy passenger carriers and two integrated express carriers. The duopoly of FedEx Express and UPS dominate the U.S. domestic market since DHL pulled out of domestic cargo and transport only international cargo. This reduction in carriers is the result of airline mergers as well as the realities of a difficult economic period. Even low-cost passenger carriers have merged, Southwest and AirTran for example, as well as integrated express carriers, such as DHL and Airborne and UPS and Menlo/Emery. The results of this shaking out within the domestic air cargo industry in terms of air cargo facilities, is that many air cargo facilities on airports no longer have a wide customer base. This has led to many vacant cargo facilities on airports or space that is not well utilized. For example, the U.S. Postal Service used to have air mail sorting facilities on most medium and large airports but has closed many since 2001 as much of its Express and Priority Mail has switched from passenger airlines to FedEx Express and UPS. On the international air cargo front the passenger gateway airports continue to experience greater tonnage growth than the domestic airports and more passenger routes and freighter routes continue to expand into U.S. airports.

CARRIER TYPES

There are three primary air cargo transport business models that impact airport facility planning. These entail the passenger airlines, the integrated express carriers (FedEx Express and UPS), and all cargo companies. A fourth type of carrier, the combination carrier, provides aircraft which carries both passengers and cargo on the main deck of the aircraft. Combi carriers are prevalent in developing nations and in areas of the world where road networks are limited. In the U.S. only one passenger airline, Alaska Airlines, operates these types of aircraft to primarily service airports in Alaska. All four of these air cargo business models have differing facility requirements and needs and even carriers within the same category, such as integrated express, have differing operating requirements and practices. UPS for example utilizes much less warehouse space than FedEx and utilizes more ramp space for cargo processing.

Passenger Airlines – A passenger airline provides cargo services to the industry by offering for sale the available capacity of the belly compartment of its aircraft, after the passenger-related items are loaded such as service cargo such as food/beverages, company material, and passenger luggage. Delta Air Lines and Southwest Airlines are examples of passenger carriers which sell belly space for cargo. Passenger belly airlines have limitations in the size of cargo they accept as they face capacity restrictions because of the combined services they offer, the size of cargo doors and payload capacity and airframe limitations. However, these airlines can provide the industry with air cargo transport flexibility, in the form of frequent flights to destinations. Moreover, in the case of Southwest, they utilize the same gauge of aircraft in their system making flight transfers easier for shippers. Such service capability reduces the chances of the cargo being bumped from a flight.

Air cargo services provided by passenger airlines vary in scope and size from airline to airline, based on the gauge of aircraft operating within their fleet. A regional airline, with a fleet of turboprop and regional jets, cannot accommodate bulky cargo due to limited cargo capacity in baggage compartments. Many passenger airlines operating transcontinental service do so with wide-body aircraft capable of accommodating containerized cargo and larger shipments. Very few wide body passenger domestic routes operate wide-body aircraft. Passenger airlines generally provide airport-to-airport service, with freight and mail carried as “belly” cargo. Freight on passenger airlines is dropped off at a warehouse at the origination airport by q freight forwarder (or the shipper); the freight is then picked up at the destination airport by the customer (or freight forwarder) after arriving on the passenger airline.

All Cargo Carriers – All cargo carriers operate airport-to-airport air cargo and freight services for their customers but do not offer passenger service. All cargo carriers include Polar Air Cargo, Atlas Air, and Kalitta Air Cargo, to name a few. Prior to its merger with Delta Air Lines, Northwest Airlines was one of the world's largest cargo airlines, operating a dedicated fleet of 14 B747F freighters. It was the only U.S. combination carrier (passenger and cargo service) to operate dedicated 747 freighters. As a result of the Northwest/Delta merger the dedicated Northwest cargo freighters have been phased out and Delta Cargo is focused on being a belly-only carrier by 2012. Internationally, Korean Air, China Airlines, Singapore Airlines, Lufthansa, and Emirates, are also passenger airlines with their own fleet of dedicated freighter aircraft. Other all-cargo carriers without passenger service include: Atlas Air, Polar Air Cargo and Kalitta. All cargo carriers offer scheduled service to major markets throughout the world using wide body and/or containerized cargo aircraft.

Heavy lift cargo freighters fall into the all-cargo carrier category and are operated by charter cargo airlines such as Volga-Dnepr Airlines and Antonov Airlines, providing specialized heavy lift operations with its fleet of Antonov An-124 and An-225 aircraft, respectively. Limited numbers of these aircraft exist as they are some of the largest aircraft in the world; therefore, operations are typically highly specialized charters and are seldom operated on a scheduled basis. These carriers transport goods and equipment for businesses and governments. This type of cargo operation is commonly referred to in the industry as project cargo.

Integrated Express (FedEx Express, UPS, and DHL) – Integrated express operators move the customer's goods door-to-door, providing shipment collection, transport via air/truck, and delivery. Dominate integrated express operators in North America include FedEx Express, UPS, and DHL (DHL's U.S. domestic pickup and delivery service was discontinued in January 2009). Express companies provide next-day and deferred, time-definite delivery of documents and small packages (two to 70 pounds). Integrated express operators are increasingly transporting "heavy" freight, (over 70 pounds). This is the next logical step in leveraging the unique scale of operations, network and other resources that these operators can bring to each business sector. Additionally, with the bankruptcies of heavy cargo carriers such as Kitty Hawk and the merger of Menlo and UPS the integrators are increasing market share in heavy freight. Integrated express operators utilize a hub-and-spoke transport model, similar to passenger airlines. The air cargo hub used for package sortation and aircraft transfer is the backbone of integrated express operators. This allows for total product connection to each market in the operator's system. Each day of operation, flights from around the North America arrive at the hub, where packages are unloaded, sorted by destination market, and then loaded onto outbound aircraft. Integrators often make heavy use of automated sorting at their hub terminals in order to achieve desired turnaround times and delivery commitments.

Regional air cargo carriers operate smaller turbo prop aircraft between O&D/local market stations and smaller or more remote cargo markets, typically in support of a larger integrated express cargo operator such as FedEx, UPS, or DHL. Wiggins Airways and Mountain Air Cargo are examples of contracted 'feeder' airlines to both UPS and FedEx. Feeder flights often transport cargo from a smaller market and feed cargo to an awaiting cargo jet bound for the carrier's hub. Feeder aircraft may also fly directly to a hub.

CARGO TERMINAL FACILITIES LOCATION STRATEGIES

A conventional air cargo terminal servicing passenger airline cargo operations should be located as close to the passenger terminal as possible to minimize the distance required to tug the cargo from the warehouse to the passenger terminal. The location should allow space for expanding the facilities when demand warrants, commensurate with master planning processes and facility requirements. New facilities must have geotechnical site constraints: earth-moving, drainage, utilities, etc. taken into consideration. A cargo hub facility for an integrated express carrier should, in contrast, be separated as far as possible from other facilities unless there is likely to be substantial cross transfer with the combination passenger carriers. Many integrators prefer to be on the opposite side of the runway, with their own taxiway system for both air cargo hubs and cargo terminal warehouses. The all-cargo terminal for freighters should also be as close to the runway as possible, without infringing on any of the runway transitional surfaces, either from the building or from the tails of parked aircraft.

Based on analysis of case study airports the locations of air cargo terminals followed three basic layout patterns:

- *Split Cargo Areas* – Passenger belly cargo warehouse(s) in proximity to pax terminal but separated from all-cargo terminal area – AUS
- *Contiguous Cargo Area* – Passenger belly cargo warehouse(s) in proximity to pax terminal and adjacent to all-cargo warehouses IAD

- *Scattered Cargo Areas* – Passenger belly cargo warehouse(s) in proximity to pax terminal but separated from a scattered all-cargo terminal area(s) IND

Air cargo that is transported in passenger aircraft is off-loaded and loaded at the passenger terminal gate. It is typically transported to the cargo terminal for handling by a tug and cart/dolly system (also referred to as cargo train) or flatbed truck over a restricted service road accessible only to cleared personnel. The transit time to and from the passenger terminal is an important planning consideration. At Indianapolis International Airport, a newly constructed midfield passenger terminal was separated from the existing cargo area by a distance of three miles and a tug time greater than 15 minutes on average. A new passenger belly cargo complex was constructed in proximity to the new IND passenger terminal to remedy this problem. At Miami International Airport a cargo access tunnel built under diagonal Runway 12-30 is used to transport belly cargo to/from the east side passenger belly cargo terminal area to the midfield passenger terminals of the airport. The tunnel has cut the trip down from an average of 45 minutes to less than 15 minutes or seven miles to two miles. The Miami example is provided to identify the level of importance in providing quick access to from the belly cargo area to the passenger terminal. It's important to point out that the speed limit on airport operations areas (AOA) is typically a maximum of 25 miles per hour in driving lanes and five miles per hour in close proximity to aircraft, buildings, or construction in progress. It is also important for the airport planner to ensure that there is enough room on the apron and within warehouse for the tug cargo trains to stage, load, unload, and pass each other with a safe amount of clearance. This results in a safer work environment for the employees, and results in less wear and tear on the equipment and on the ramp area and cargo buildings.

Conversations with operators of belly cargo terminals indicated that tug time to the passenger terminal is of paramount importance to the carrier. Based on the evidence provided by carriers and the research associated with this study, a table of viable tug times between passenger belly cargo areas was developed based on airport cargo traffic volumes.

Table 9-1 Viable Tug Driving Times.

ACI Airport Grouping	Annual Volume of Cargo	Viable Tug Driving Time Between Belly Cargo Area and Passenger Terminal
Small	100,000 or less metric tons	1 to 5 minutes
Medium	100,000 – 499,999 metric tons	5 to 10 minutes
Large	500,000 or more metric tons	10 to 20 minutes

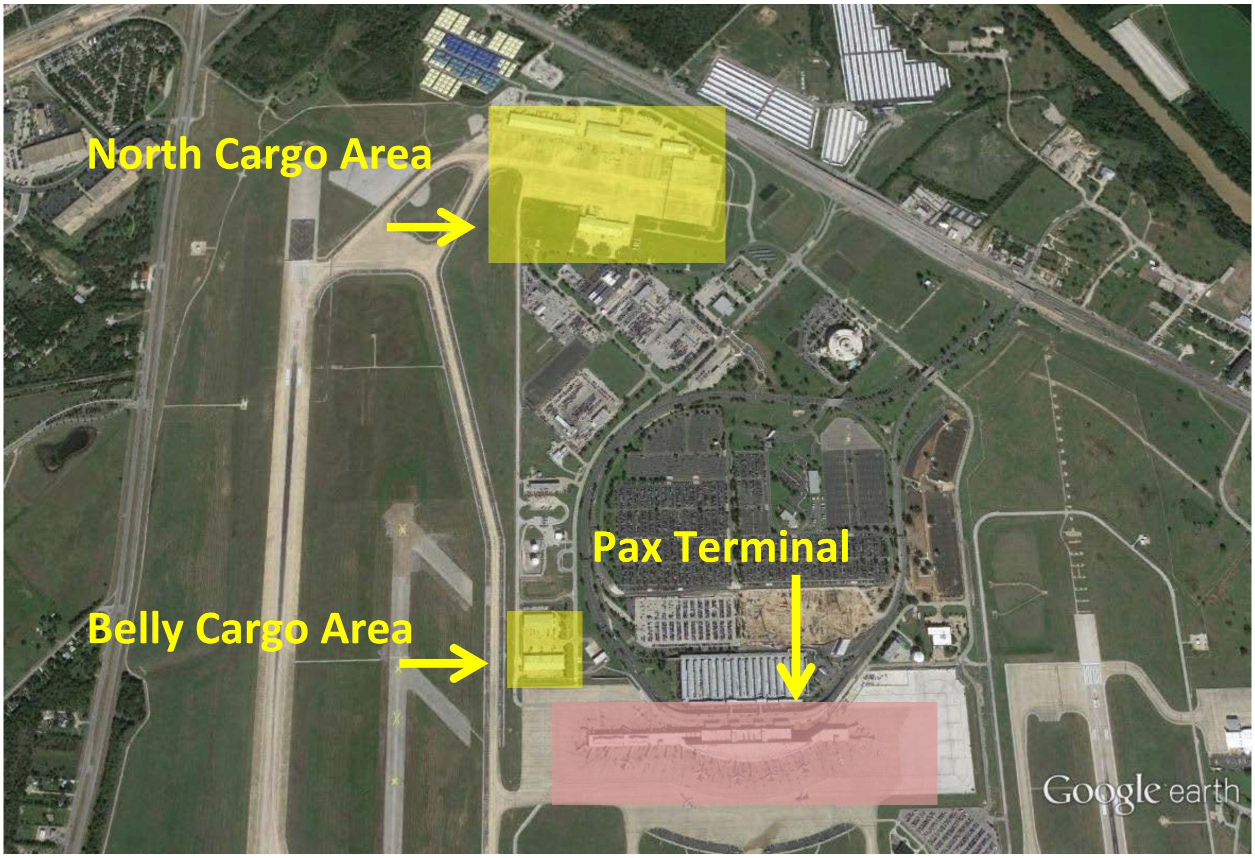
SOURCE: CDM Smith.

Note: The 2002 ACI Air Cargo Facility & Security Survey, separated airports into three groups of which the research team followed suit.

Example Split Cargo Areas

Cargo facilities at Austin Bergstrom International Airport AUS are a good example of a Split Cargo Areas location strategy. The airport has two cargo development areas with the belly cargo area 0.6 miles from the center of the passenger terminal ramp. The airport's North Cargo Area is designed for all cargo operators and is located directly at the front of the airport, right on Highway 71, the main road leading to central Austin. The North Cargo Area provides immediate access to the airports taxiway system and Runway End 17 Right. Both cargo areas share the same entrance, appropriately named "Cargo Road," and has a prominent position on the airport site. Figure 9-3 identifies the belly cargo and all cargo areas on the airport. Interestingly, the City of Austin chose to have 100% of their cargo facilities developed by third-party developers—one of the few completely privatized airport sectors in the country. To make this point even more unique, three different developers built and operate the facilities to this day. Very few airports have such competition and the result is a wide range of options and congenial attention to the customers' requirements.

Figure 9-3 Austin Bergstrom International Airport – Cargo Area Location. (SOURCE: Google Earth Pro, CDM Smith Analysis.)

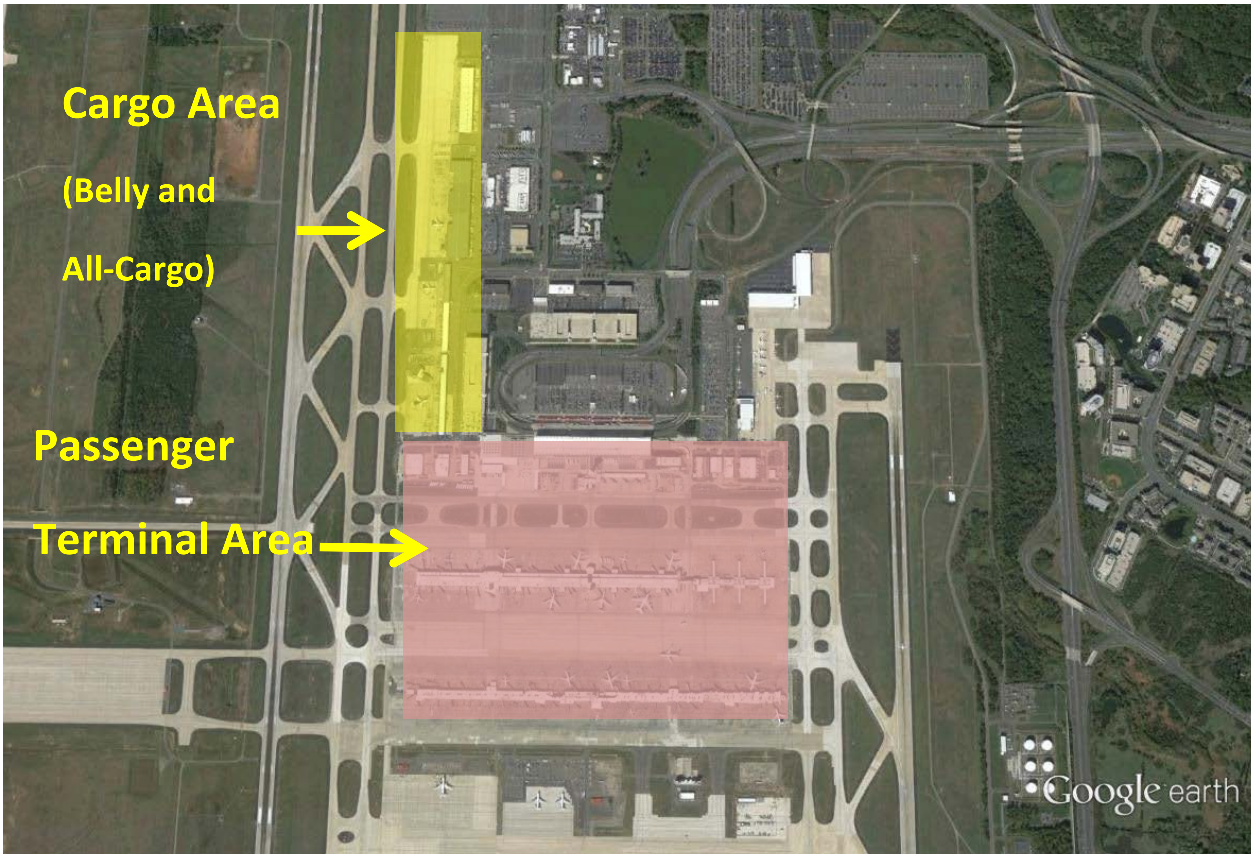


Example Contiguous Cargo Area

Cargo facilities at Dulles International Airport IAD in Washington, DC are a good example of a Contiguous Cargo Area location strategy (Figure 9-4). Contiguous Cargo areas have passenger belly cargo warehouse(s) in proximity to the passenger terminal and are adjacent to all-cargo warehouses. Also, in designating land for future air cargo development, airports can reduce the overall cost of developing an air cargo facility by designing a common use aircraft parking apron. Common use aprons such as these are eligible for FAA grant funding which removes much of the cost of the aircraft parking apron from the facility development cost.

Dulles' air cargo facilities are primarily four relatively large cargo buildings totaling about 500,000 ft^2 of space all contiguous to each other. All of the cargo is carried through belly cargo on passenger airlines with the exception of FedEx Express, UPS, and DHL. Metropolitan Washington Airport Authority (MWAA) is also seeking to attract all cargo carriers with transoceanic international routes.

Figure 9-4 Dulles International Airport – Cargo Area Location. (SOURCE: Google Earth Pro, CDM Smith Analysis.)

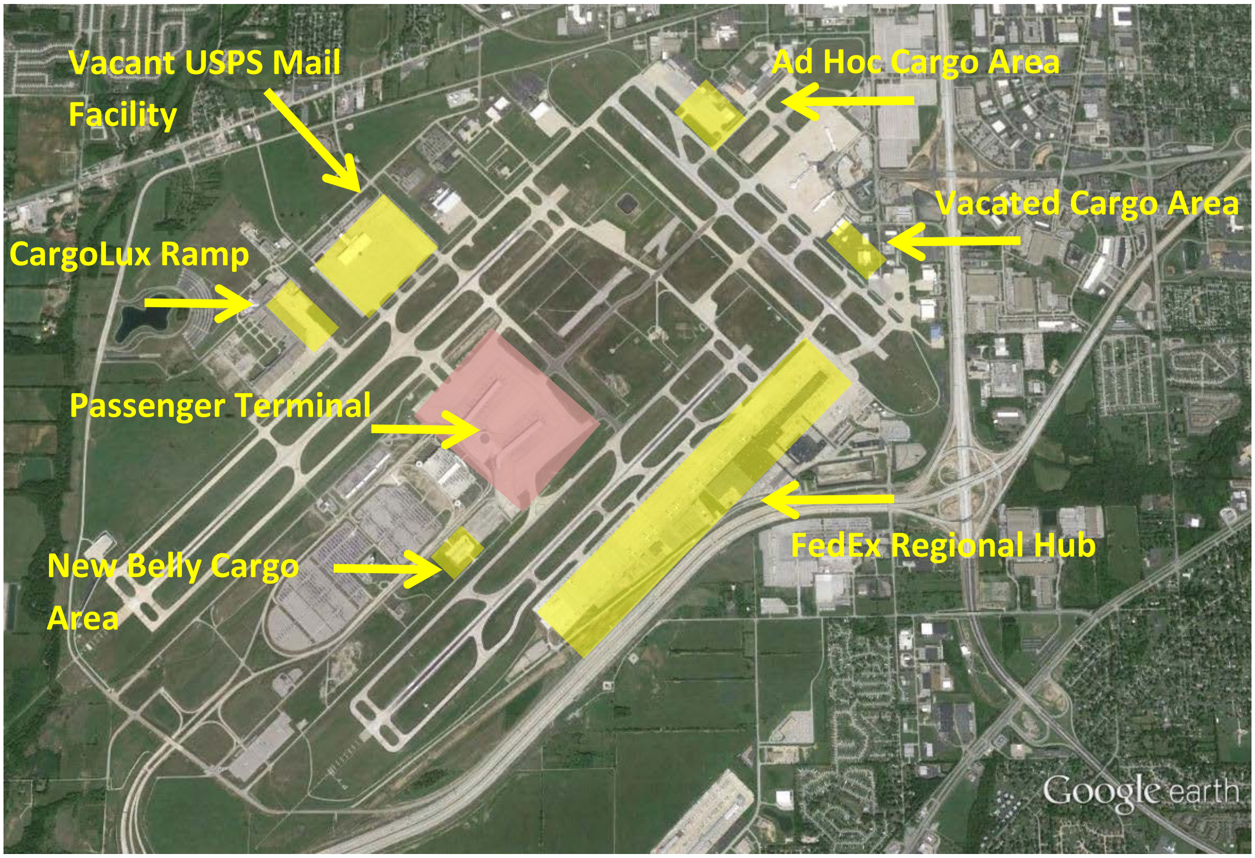


It is noteworthy to point out that MWAA has 400-acres on the west side of the airport earmarked for air cargo expansion to double their cargo capacity. Should this be developed the airport would fall into the Split Cargo Areas strategy.

Example Scattered Cargo Area

Cargo facilities at Indianapolis International Airport IND are a good example of a Scattered Cargo Areas location strategy (Figure 9-5). As stated previously, a newly constructed midfield passenger terminal at Indianapolis International Airport was separated from the existing cargo area by a distance of three miles and a tug time greater than 15 minutes on average. A new passenger belly cargo complex was constructed in proximity to the new IND passenger terminal to remedy this problem. The distance between the new belly cargo area and the center of the midfield passenger terminal ramp is one mile or less than five minutes.

Figure 9-5 Indianapolis International Airport – Cargo Area Location. (SOURCE: Google Earth Pro, CDM Smith Analysis.)



FACILITY INVENTORY AND DATA COLLECTION

The first step in developing this strategic plan is to define the current situation at the airport. Airport planners should complete an inventory of current air cargo facilities, associated ramp space and truck circulation space, their capacity, and the percentage of that capacity the users of those facilities are currently using to process the current level of air cargo handled at the airport. Surveys should include online or paper surveys as well as face-to-face interviews with air cargo stakeholders. This will provide insight into whether the current air cargo facilities and ramp space have ample capacity to accommodate increases or whether additional air cargo facility capacity will be required in the near or long term. When conducting this inventory, airport planners should focus on the land and facilities required by airlines, integrated carriers, and air cargo handlers for both air cargo handling and ground support equipment (GSE) storage and maintenance. Larger airlines, integrated carriers and ground handing companies with large fleets of GSE require sizable facilities to maintain their GSE fleets and equipment. If the integrated carriers choose to maintain their delivery trucks on airports, due to the magnitude of their truck fleets, larger maintenance facilities may be required.

When completing an inventory of air cargo facilities, airport planners should also consider the air cargo facilities located off-airport and the economics of a user having an off-airport air cargo facility versus locating that facility on-airport. In many cases, it is more economical for a user to purchase land off-airport and construct an air cargo facility versus leasing land and constructing an air cargo facility on airport. By understanding the economics of developing or operating an off-airport versus on-airport air cargo facility, airport planners will gain insight into the competitiveness of the airport's rates and charges and may have to adjust land and facility rents. This will be addressed in the Strategic Development section of this chapter.

Once a comprehensive inventory of all air cargo and support facilities has been completed for a given level of air cargo volume, airport planners should focus on the development of an air cargo forecast. It is noteworthy to point out that the research team arrived at similar conclusions with *ACRP Report 96: Apron Planning and Design Guidebook* in that the inventory effort includes:

Interviews with stakeholders, including airport management, airlines serving the airport, airport tenants, and third-party providers. The goal of the inventory process is to ensure a thorough understanding of the physical, environmental, business, and operating environment to ensure appropriate consideration during the planning and design processes. A paper survey or online survey may not collect some of the nuances of the air cargo industry's on-airport operations.

DEVELOPING THE AIR CARGO FORECAST

Several forecasting methods were previously presented that airport planners should use to develop a base line air cargo forecast, but it is important to solicit the input from the airlines and other companies involved in processing air cargo at the airport, as well as to have an understanding of the broad goals and objectives of the market the airport serves.

Most airlines at the airport have their own air cargo volume forecast. Some are willing to share forecasts with airport planners and others consider it proprietary and are not willing to disclose future plans to a public agency. Ascertaining as much information as possible from the airlines, integrated express carriers, and ground handling companies concerning the volume of air cargo they anticipate in the future and their plans for accommodating that volume of air cargo is critical. While the air cargo forecast should cover a ten- to twenty-year planning horizon, the requirements for the next five plus years is crucial to generate the tactical initiatives necessary to meet the near-term demand.

There are also several macro forecasts for air cargo. Annually, the FAA produces a macro forecast for air cargo for the nation and periodically Boeing, Airbus and IATA produce macro forecasts. While these forecasts present how much air cargo is forecast to grow over a future time period, unfortunately, they are not necessarily representative of what could be expected on a local level.

Another source of information on the current state of the air cargo industry in the U.S. and what should be expected in the future are the air cargo trade publications. There are several magazines that provide much background and detail on the air cargo industry including innovative solutions to handling air cargo efficiently and to providing sufficient capacity to accommodate air cargo volumes. Understanding the airport's role in the community, the community's goals and objectives, and the community's growth plans is paramount. Cities and counties develop plans for their area that include a population growth forecast, identify which industries in the community are targeted for growth, and forecast the number of jobs that will be created over the forecast period. If a community's population and job forecast is robust, then airport's air cargo forecast should reflect that growth in some industries will generate additional air cargo volume while others will not. A community's local or state economic development agency has much insight into what sectors of industry are growing and whether those sectors will generate additional air cargo volume at an airport. In many communities, the airport is viewed as the community's economic engine and the volume of activity at the airport mirrors the volume of activity and growth in the community. A good airport air cargo forecast is one that is in tune with its community's growth forecast and if it's a hub airport, in tune with national and global economic growth. However, at airports where air cargo hub operations exist, not only does the airport's air cargo forecast need to reflect the growth in the local community, but also the growth in the hub operation where growth is dependent upon the feeder markets collectively.

After reviewing the airline and integrated carriers forecasts, the macro forecasts, and the community's growth forecast, airport planners should have the foundation for developing an air cargo forecast that is realistic. Often, these forecasts are accompanied by upside and downside potentials that provide a range of air cargo volume to be expected that help in mitigating risk when committing land and facility capacity. Depending on the size of the airport and the complexity of its air cargo operation, airport planners may engage outside professionals to develop their air cargo forecasts.

SOURCES OF FORECAST INPUTS

Virtually all U.S. airports at least track total cargo volume, as well as subsets such as freight (including express) and mail on a directional (inbound and outbound) basis. Commonly, these data sets are managed by airport accounting departments compiled from monthly operations reports used to settle landing fees and satisfy other carrier reporting requirements. For those airports to which it is applicable, cargo will also be organized into domestic and international increments. In addition to tonnage data, monthly airline reports provide critical inputs pursuant to frequencies and aircraft types. There is no single standard for how or if airports generate public reports from this and other data.

Air cargo tonnage is typically reported by airports on an annual basis but monthly reports are useful to isolate seasonal trends. Planners can use secondary references (such as OAG's Cargo Flight Guide) or request carrier schedules to record flight operations in peak period analysis – critical where aircraft parking ramp is at a premium. It is advisable to use multiple sources of primary and secondary inputs.

A variety of institutional sources are commonly used to calibrate individual airport forecasts, including forecasts by Boeing, Airbus, IATA and the FAA. For specialized facilities – such as cold storage – airport planners may seek trade data originating with U.S. Customs & Border Protection (CBP). Much trade data can be accessed at no cost. There is no substitute for the unique perspectives obtained through original interviews and surveys with on-airport cargo-related tenants, as well as key off-airport constituencies.

FORECAST METHODOLOGIES

Time Series Trend Analysis

One of the most common forms of statistical analysis is the discrete time series, in contrast with the continuous time series which records an observation at every instant of time, which observes phenomenon through regularly spaced intervals. To be used as a predictor, time series analysis requires confidence that the period to be forecasted will be much like the period from which the trend multiplier (usually a Compound Annual Growth Rate – CAGR) was derived. One of its weaknesses is that it does not reflect volatility which can be substantial from one year to another but rather creates the illusion that there is a steady growth rate. It is noteworthy to point out that time series analyses are commonly used to "inform" airport planners of future growth rates based on historical activity but does not completely dictate growth rates since the market is susceptible to volatility.

For many years, a twenty-year horizon was the accepted time frame for forecasting. Clearly, the early years had the greatest credibility with the most distant years the weakest. Airport activity has been volatile as the airline industry has been impacted by uncontrollable factors such as escalating fuel prices, economic swings and labor issues.

Longer historical periods are still often preferred but the beginning and ending years of the time series should be closely scrutinized for the effect that anomalous years can have on trend analysis.

On the other hand, a longer time series must be qualified in terms of applicability because the industry itself has changed so greatly since the 1990s. In international gateways, gains in international cargo tonnage have at least partially masked losses in domestic cargo.

Even if only to provide a contrast, time series analysis remains a useful planning tool. The ideal use for trend analysis has been described as a mature industry experiencing relatively consistent, gradual growth – a description that contrasts greatly with the recent experience of the U.S. air cargo industry.

Regression Analysis (Econometric Modeling)

Regression analysis is a statistical technique for estimating relationships between a dependent variable and one or more independent variables. Regression analysis helps explain how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed. It is widely used for prediction and forecasting as well as to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables with the critical caveat that correlation does not always prove causation.

The dependent variable of air cargo growth may be associated with such independent variables as jet fuel prices, gross domestic product (GDP), composite leading indicators (CLI) and population – customarily using a combination of time series and growth curves.

Like time series analysis, regression analysis is a useful tool to evaluate historical relationships between cargo growth and other econometric elements. However, it is an imperfect (wildly so in some circumstances) predictor of future trends – not least because of its assumption of unlimited capacity supply – and therefore should be considered only one of several potential analytical tools.

Market Share

Market share analysis compares local activity levels with a larger entity, most commonly in comparisons between a particular airport and its regional or total national traffic. Historical data is used to establish the ratio of local airport traffic to total national traffic – customarily using source data from the FAA Aerospace Forecasts document for national data.

Much like the preceding methodologies, Market Share has limitations as a predictor. Most obviously, this methodology assumes that the proportion of activity that can be assigned to the local level is a regular and predictable quantity. As has already been established, the U.S. air cargo industry remains in the midst of a prolonged period of contraction that has touched most airports but not equally.

Indications in late 2012 from the two dominant integrators suggested that near to medium-term domestic fleet utilization strategies may favor up-gauging aircraft size but serving fewer U.S. markets by air, while expanding the utilization of trucks for domestic feeder service. The impact may negate organic air cargo growth at many small and medium-sized markets or conversely may support growth at strategically located airports that can potentially serve as access points to multiple possibly larger markets. All of the preceding suggests that imperfections exist in market share modeling, as it pertains to projecting local airport trends relative to regional and national growth.

At the individual airport level, market shares of international and domestic, as well as belly cargo versus freighter cargo are essential for facilities planning as this analysis informs judgments about future demand for freighter positions and other related considerations. Carrier market share – possibly through the prism of ground handlers possibly serving multiple carriers in a common warehouse and ramp space – is necessary for calculating the individual utilization rates of cargo facilities.

In summary, market share analysis is an essential piece of air cargo analysis at the individual airport level but as a predictor of future relationships between local and national trends, it must be qualified.

Institutional Forecasts

For the vast majority of U.S. airports, only domestic cargo is materially significant. However, at international gateways, directional (import and export) forecasts will often be segregated by region (for gateways with multiple transcontinental routes), although often a composite international multiplier entails the international market share and growth rates of each individual segment.

Using institutional forecasts is not a substitute for other methodologies but more accurately a surrogate for the labor involved. Entities such as Boeing and Airbus perform intensive econometric modeling (GDP and fuel prices, to name but two independent variables) to inform their biennial forecasts. If such institutional forecasts are used as the basis for individual airport forecasts, adjustments should be made to recognize local conditions.

The latest Airbus effort is their “Global Market Forecast: 2012 – 2031.” It is an integrated document entailing both passenger and cargo forecasts – contrasted with Boeing which releases separate reports. Passenger forecasts are available from both sources and may be of particular use in incremental considerations of belly cargo capacity versus freighter demand. Both Airbus and Boeing forecasts are available as free downloads from the corporate websites. Significantly, both companies' cargo forecasts project growth rates in terms of revenue-ton-kilometers (one ton of revenue-producing cargo flown one mile (Boeing) or kilometer (Airbus)), which clearly put a premium on longer-haul segments. One disadvantage of the Airbus forecasts has been that detailed cargo forecasts have been produced in less reliable intervals. A significant advantage is that Airbus' market forecasts tend to be segmented into much smaller sub-continental groupings allowing more precisely delineated pairing of routes and markets. Boeing's "World Air Cargo Forecast 2012 – 2013" is the latest biennial installment of the cargo-specific document. The Boeing twenty-year (through 2031 in the latest installment) forecast is compiled from econometric models and airline interviews undoubtedly enriched by Boeing's dominance in the freighter market and resultant access to the insights of the world's dominant freighter operators. It has the significant advantage of a timely production schedule and relatively uniform structure over time – facilitating the reuse of forecast templates by airport planners. The popularity of Boeing's forecasts derives in large part to the acceptance of its methodology and its history of reliability.

The FAA Terminal Area Forecast (TAF) (latest currently being for Fiscal Years 2011 – 2040) provides summary historical and forecast statistics on passenger demand and aviation activity at U.S. airports based on individual airport projections..

The principal input for the TAF is the FAA Aerospace Forecasts (Fiscal Years 2013 – 2033 just being released). Typical of econometric models, the FAA Forecasts assume unconstrained capacity. They also assume no further contractions of the industry through bankruptcy, consolidation, or liquidation. Even since publication, these assumptions have likely already been significantly compromised and the FAA wisely filled its narrative with cautions accentuating the recent unpredictability of commercial aviation. Both the FAA Aerospace Forecasts and the TAF are repositories of economic data that may be useful in conducting regression analyses. They also possess forecasts for passenger activities useful in considerations of potential belly capacity available for cargo.

The air cargo element of the FAA Aerospace Forecasts (in revenue ton miles – RTMs) assumes that security restrictions on air cargo transportation will remain in place and that most of the shift from air to ground transportation has already occurred. Finally, the forecasts assume that long-term cargo activity will continue to be tied to economic growth. While obviously uncertain, these assumptions are defensible

The International Air Transport Association (IATA) produces an annual cargo-specific forecast that is stratified into more narrow market segments than any of the preceding forecasts. Its liabilities include that the detailed version must be purchased and it is only completed in 5-year increments. Potentially among the most illuminating sources of forecasts would be the air carriers which commonly develop in-house forecasts with 5-year increments being common for traffic and 5-10 year increments for fleet forecasts. Unfortunately, these forecasts are considered commercially sensitive and therefore rarely shared with airport operators and/or their consultants. However, the preferred collaborative process of developing forecasts should present the opportunity to at least test the airport's own forecasts against perceptions of the carrier-tenants. Moreover, the carriers will typically provide input into operations forecasts pursuant to fleet expectations for the near to mid-term.

Operations Forecasts

Airports' cargo operations forecasts are principally derived from tonnage forecasts. As much as tonnage is a critical input for planning warehouse capacity, operations are critical for planning ramp capacity.

Airport planners need as much feedback as possible pursuant to carriers' fleet and route planning. While the gauge of aircraft is critical to calibrate aircraft capacity, it is also critical to know how much of the payload is dedicated to the local market. If the aircraft continues to other cities to build/break loads before returning to the hub, partial loads decrease throughput anticipated for the warehouse and may shorten the time the aircraft will be on the ground.

A thorough understanding of airline schedules may allow airport planners to maximize the use of aircraft ramp positions. Airport planners can extract current fleet and flight operations data from landing reports and flight schedules from proprietary sources such as OAG Cargo Flights. Industry-wide fleet information can also be gained from Airbus and Boeing, as well as from outstanding secondary sources such as Cargo Facts produced by Air Cargo Management Group. Interviews with cargo carriers (and handlers where applicable) are indispensable to verify potentially outdated secondary sources, as well as to gain unique forward-looking insights into prospective future operations on a specific market basis.

In order to derive operations from tonnage, airport planners must first determine the market share presently transported by passenger carriers and then make assumptions about future trends pursuant to that distribution. The FAA Aerospace Forecast provides such forecasts for both domestic and international cargo on a national airport system basis.

Once that belly cargo has been deducted from total cargo to isolate the tonnage that specifically drives demand for freighter operations, planners must make assumptions about the carriers' payload limits that would trigger either additional frequencies or a change in gauge of aircraft. It is also critical to know if the local market is presently served by the carriers as a stand-alone destination or as part of a multi-stop routing in order to evaluate how much capacity is available before another frequency would be required. Unlike passenger service that very often is daily, freighter service at many U.S. airports may only be weekday with perhaps partial service on weekends. Consequently, airport planners may use an annual standard of 282 annual cargo days (5.5 days/week), adjusting according to local schedules which may only have weekday (5 days/week or 260 days/year) or alternatively full calendar (7 days/week) service. Operations will typically be forecasted on a three-tier basis compatible with tonnage forecasts on low, base and high case scenarios. Additional matrices can easily be formed to create alternative forecasts on the basis of a range of load factors.

Planners at airports with relatively modest cargo operations may opt for a simpler approach comparable to the "market share" methodology described earlier. Applied to operations, the approach would entail simply calculating the tons/operation that the airport has recently experienced and then applying that average to future tonnage forecasts. On an applied basis, airport planners may combine the tons/operation with the airport's number of ramp positions (recognizing variable capacity) and aircraft turns per day per position, in order to determine total ramp capacity in tonnage terms.

FORECAST EXAMPLES

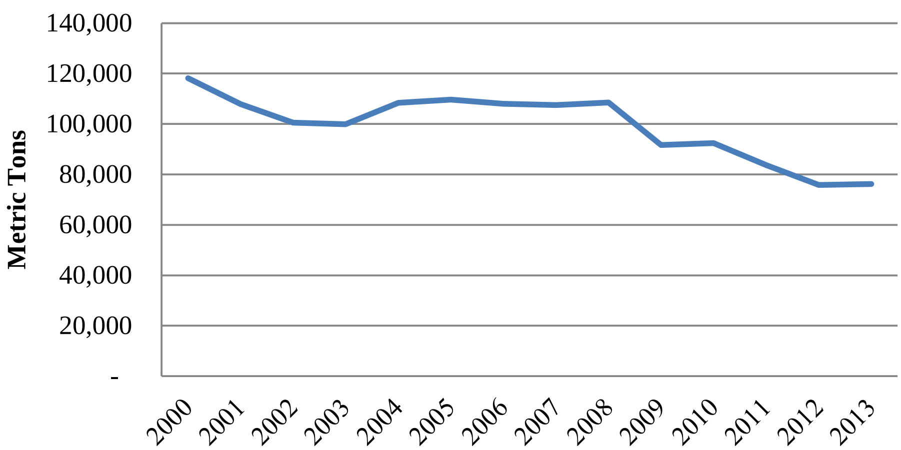
The following section uses forecasts for specific airports and presents a range of airport types with both declining and increasing historic tonnages. Three U.S. Airports were selected. RDU provides the example of the non-gateway, non-hub airport much like the majority we have studied, while ONT exemplifies a regional integrator hub and potential international alternative to LAX. Atlanta provides forecasts for a major U.S. international gateway airport. The analysis identifies how greatly forecasts can be affected simply by the choice of a base year data as well as market-specific considerations.

Raleigh-Durham International Airport (RDU)

Raleigh-Durham International Airport (RDU) is representative of many U.S. airports in that it is neither an international gateway, nor a regional hub for integrated carriers. RDU was a passenger hub for American Airlines until that hub closed in 1995.

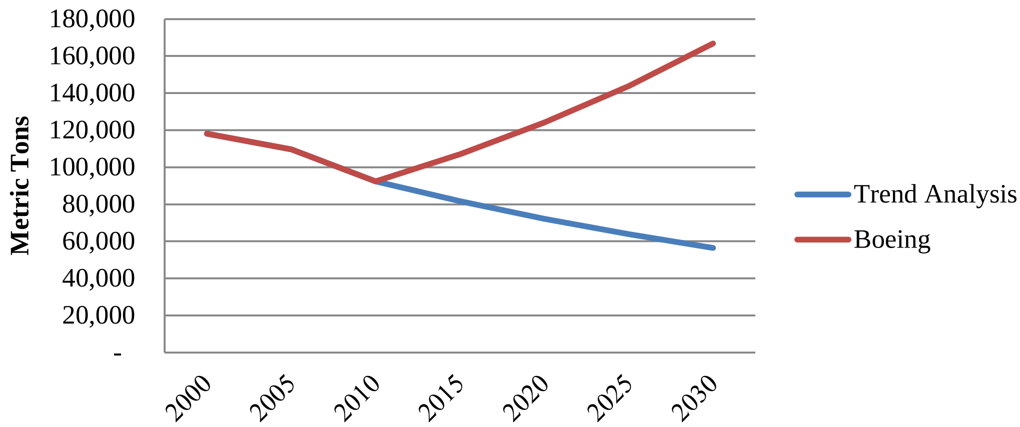
RDU has experienced substantial losses since reaching its peak annual cargo total in 2000 with 118,115 metric tons (MTs), falling 35.5% through 2013 to an annual total of 76,204 MTs. The base period for this study's earlier chapters was Calendar Year (CY) 2000 through 2010 – a period during which RDU's cumulative annual growth rate (CAGR) had been -2.43%, as RDU total cargo had ended the period with 92,361 MTs in 2010 (Figure 9-6).

Figure 9-6 RDU Total Cargo: CY 2000 – 2013. (SOURCE: Airports Council International, Webber Air Cargo Analysis.)



As explored in Subtask 5, Air Cargo Forecast Techniques, a variety of methodologies can be applied to an airport's forecasts and the outcome can be affected by several obvious factors. In the specific case of RDU, the magnitude of the decrease is magnified by the fact that the first year (2000) in the applied range happened to be RDU's historical peak year. The inverse can also occur when a particularly low year is used in the calculation. As depicted in Figure 9-7 below, a trend analysis or time series using the -2.43% CAGR from 2000 – 2010 would project annual total cargo descending to less than 57,000 MTs through CY 2030. However, the application of such a methodology requires confidence that the past is an accurate predictor of future events. Many events—skyrocketing fuel prices, global recession, wars, modal diversion—have led to unprecedented losses in the air cargo industry that most informed observers believe are unlikely to be replicated.

Figure 9-7 RDU Total Cargo Forecasts: CY 2010 – 2030. (SOURCE: Airports Council International, Webber Air Cargo Analysis.)



An alternative approach may be to utilize the Boeing (or another institution's) forecasts to calibrate RDU's cargo forecasts. In Figure 9.17 above, Boeing's forecasted growth rate of 3.0% for the intra-North America market was applied to the period beginning in base year CY 2010 through CY 2030. As detailed in Subtask 5 and according to the 2010 to 2011 Boeing World Air Cargo Forecasts, the Boeing forecasts are not so much a substitute for other methodologies but rather a means of leveraging the econometric modeling that Boeing performs by region. In contrast with the continuous erosion of annual tonnage resulting from the time series application, the growth projected by Boeing would result in a CY 2030 annual cargo total of almost 167,000 MTs. RDU would be forecasted to return to its 2000 peak tonnage in CY 2019.

While Boeing and other institutions forecast growth rates for numerous trade lanes, RDU's international air cargo predominantly is trucked to/from international gateways and so the intra-North America growth rate is exclusively applicable for the market. Usually a high and low alternative forecast will be developed and one assumption guiding the high case may well be the introduction of international freighters. Because RDU is in close proximity to a FedEx regional hub in Greensboro, NC and a UPS regional hub in Columbia, SC, the airport is unlikely to be the beneficiary of any unusual growth from either integrator that currently dominates the airport's market shares.

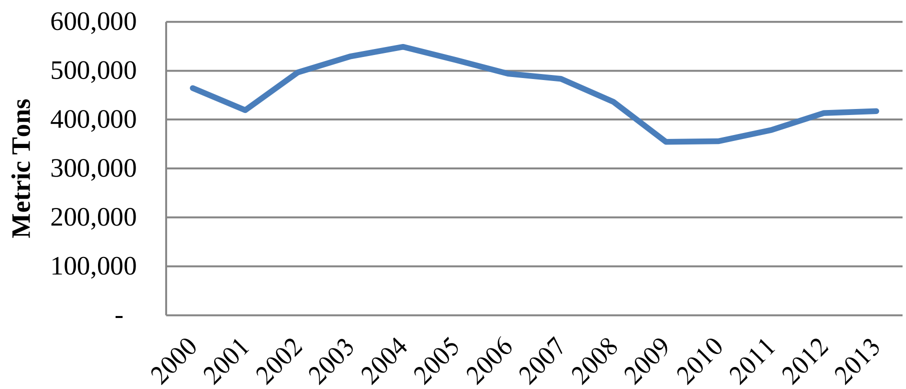
While such institutional forecasts are helpful for calibration, those forecasts are often performed on a national or even continental basis, so forecasters may further tweak growth rates using anticipated metro or regional production and other variables to determine whether the local market is anticipated to grow above or below national expectations. These forecasts can then be compared with available facilities capacity to identify potential deficits. Particularly in a market with so few major cargo tenants, as much direct input should be gathered from carriers as possible.

LA/Ontario International Airport (ONT)

LA/Ontario International Airport (ONT) consistently ranks among the 20 largest U.S. airports total annual cargo, almost entirely on the basis of its western region hub for integrator UPS, which also operates a regional trucking hub from the same location. ONT is operated by Los Angeles World Airports – operators of Los Angeles International Airport – and was long suggested as the "heir apparent" of overflow freighter traffic from LAX but the cargo industry downturn has likely delayed that need by at least a decade.

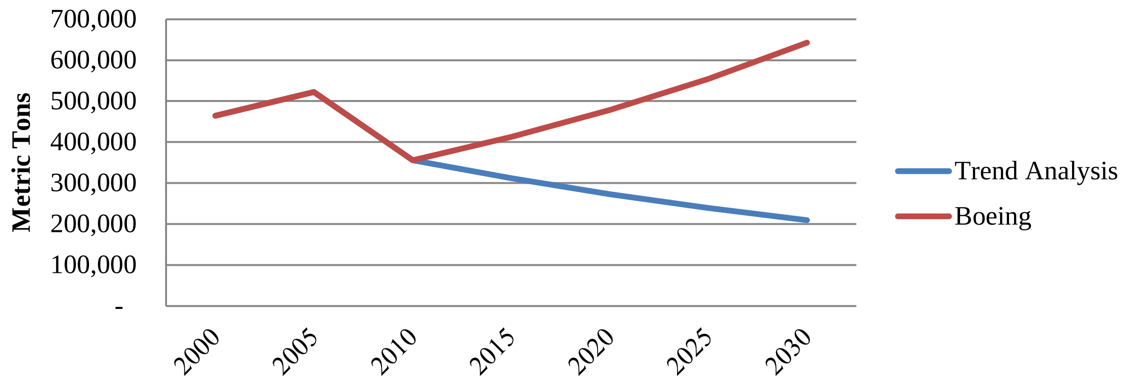
For many of the same reasons cited already in this study, ONT has experienced cargo losses. Unlike many other airports, ONT's UPS hub enabled the airport to continue growing in the years immediately following 9/11 when the integrators tended to fare better than belly carriers in the U.S. domestic market. ONT actually reached its peak annual cargo total in 2004 with almost 550,000 metric tons (MTs). As evident in Figure 9-8 below, ONT hit its low point for the period in 2009 before slightly recovering in 2012 and 2013. Obviously, the calculation of ONT's losses would be dramatically affected by whether the starting year had been CY2000 or its peak year of CY2004 and similarly whether its final year had been the low period of CY2010 or CY2013. Since CY2000, ONT's total annual cargo had fallen about 23% through 2010 but with a recovery was down only 10% through 2013 (Figure 9-8).

Figure 9-8 ONT Total Cargo: CY 2000 – 2013. (SOURCE: Airports Council International, Webber Air Cargo Analysis.)



As depicted in Figure 9-9 below, a trend analysis or time series using the -2.62% CAGR from 2000 – 2010 would project annual total cargo descending to less than 210,000 MTs through CY 2030. Again though, such a negative trend is not anticipated to persist and indeed, ONT's cargo tonnage had already turned in a positive direction in consecutive years of 2011 through 2013.

Figure 9-9 ONT Total Cargo Forecasts: CY 2010 – 2030. (SOURCE: Airports Council International, Webber Air Cargo Analysis.)



As in the preceding example involving RDU, applying another methodology will produce a dramatically contrasting cargo forecast for ONT. For consistency's sake, again applying the Boeing forecast for intra-North America cargo growth rate (3.0%) will result in total annual cargo of almost 643,000 MTs through CY2030. However, ONT should likely have a slightly larger growth rate applied, due to the small international component of ONT's cargo transported to/from China by UPS. Because this cargo is precleared in Anchorage inbound and often sorted in ANC outbound, much of it gets counted as domestic cargo at ONT but some share of ONT's cargo forecasts should receive the higher (6.7%) growth rate projected for North America-Asia for the period.

In the case of ONT, serving the same region as LAX and operated by the same entity, it is more likely that additional international freighters could potentially be moved from LAX to ONT during the next twenty years. In long-range forecasting, perfect estimations are far from likely and so documenting the forecasters' assumptions become even more critical to understanding the inevitable deviations from the forecasts. In the case of ONT, these assumptions – at least for a high case scenario – would possibly include positive increases in international tonnage as UPS potentially expands these operations from its western region hub and transpacific gateway, as well as potential freighter operators migrate from what could be an increasingly congested LAX to relatively nearby ONT. On the other hand, forecasters may dampen the latter expectations on the basis of increased belly capacity from cargo-friendly aircraft operating transpacific routes.

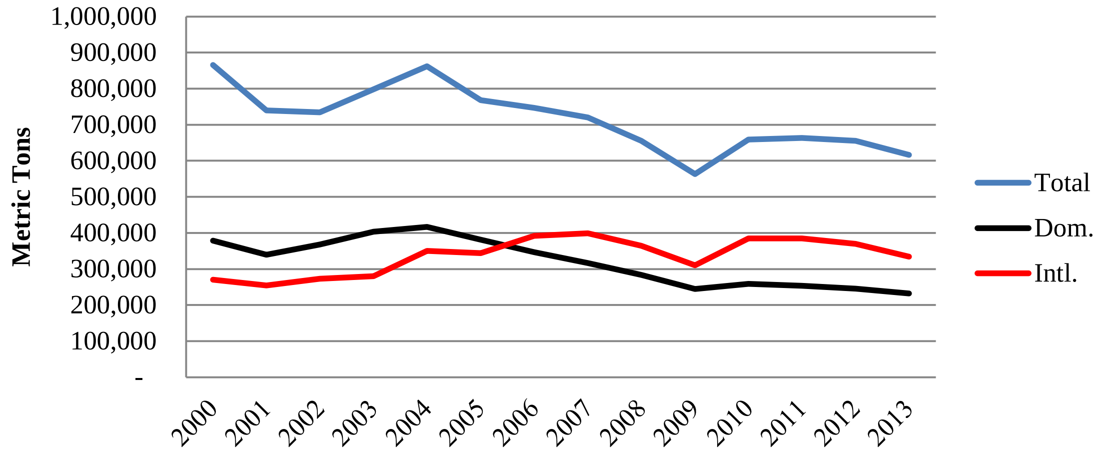
For the near-term, ONT's capacity concerns are likely to remain fixated on accommodating the UPS hub and FedEx – much like other U.S. airports but with the obvious distinction in scale caused by UPS' hub. Each of these operators has their own dedicated facilities at ONT and the losses of the last decade should leave them with surplus capacity. However capacity management in the mid to long-term will require consideration of the flagship, LAX, into more of a system capacity model.

Hartsfield-Jackson Atlanta International Airport (ATL)

Hartsfield-Jackson Atlanta International Airport (ATL) finished 2012 ranked #10 among U.S. airports in total cargo. Unlike the previous two examples – RDU and ONT – which are dominated by the domestic operations of integrated carriers FedEx and UPS, ATL is a major international cargo gateway, served by numerous foreign passenger and all-cargo carriers as well as its hub carrier Delta Airlines.

As is evident in Figure 9-10 below, ATL experienced an almost 30% decrease in total cargo between CY 2000 and CY 2013 (inclusive). However also evident is that ATL experienced very different outcomes in its two main cargo segments, as international cargo actually rose by more than 23% for the period but this gain was insufficient to overcome an almost 39% decrease in domestic cargo. For the first time in the airport's history, international tonnage exceeded domestic tonnage in 2006. At international gateways such as ATL, losses in domestic tonnage are not only attributable to domestic shipments but also to the losses of domestic segments of international shipments that previously may have been flown to/from domestic feeder cities to the gateways but are now much more commonly trucked.

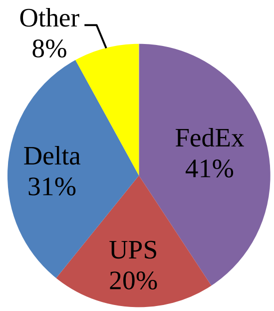
Figure 9-10 ATL Total, International & Domestic Cargo: CY 2000 – 2013. (SOURCE: Airports Council International, Webber Air Cargo Analysis.)



Not only have the performances of domestic and international cargo contrasted greatly at ATL in recent years, but the market share composition contrasts greatly as well. The one unsurprising constant is that ATL's passenger hub carrier Delta accounts for roughly one-third of both domestic and international cargo. Contrasted with most U.S. commercial airports at which the integrated carriers account for more than 95%, ATL still has significant market shares of cargo transported by belly carriers – not only Delta but also Air France (3.7%), British Airways (6.6%), KLM Royal Dutch Airlines (2.0%), Korean Air (9.0%) and Lufthansa (8.1%). Cumulatively, they give belly cargo carriers a market share in excess of 50% of ATL's international cargo.

Apart from the 31% market share of Delta, ATL's domestic market mostly conforms to U.S. trends in being heavily concentrated with both FedEx and UPS having large market shares totaling over 60%.

Figure 9-11 ATL Domestic Cargo Market Shares: CY 2013. (SOURCE: City of Atlanta Department of Aviation, Webber Air Cargo Analysis.)



As should be evident from the preceding tasks in this study and even the preceding examples in this subtask, the distinctions between types of cargo and types of carriers are far more than academic in terms of forecasts and facilities. Unlike most U.S. airports at which slight deviations on institutional forecasts for intra-North America growth may be adequate, the ATL forecasted growth rate would require a composite of expectations about not only domestic cargo but also trade with Asia, Europe, Latin America and the Middle East. All of these trade lanes are anticipated to grow faster than intra-North America in the next twenty years. It should also be noted that a substantial part of Delta's domestic cargo is likely to be the domestic segment of international shipments and therefore should also be adapted with a growth rate that accounts for anticipated higher growth for international.

Detailed in Subtask 5 – forecasts for ATL should be stratified for cargo carried by passenger and freighter aircraft. As noted elsewhere, reasonable expectations exist that more cargo-friendly transcontinental passenger aircraft will continue to gain international cargo market share at the expense of freighters. Forecasters would need to document their assumptions about the potential shift in order to justify the growth rates applied to belly cargo carriers and freighter operators. This impact of this distinction will be most obvious in projecting potential ramp demand as increases in belly cargo may reduce the need for additional ramp positions for parking freighters.

As with the examples of RDU and ONT, forecasters should attempt to garner as much input as possible from representatives of the air carriers. Obviously the task will be far more challenging at a gateway such as ATL where far more carriers are potential sources of invaluable insights and the headquarters of many of these carriers are overseas. Nonetheless, few worthy substitutes for that input exist.

METHODS USED IN RECENT AIRPORT PLANNING EFFORTS

During this study's Literature Review, the consultants reviewed twelve airport master plans completed between 2005 and 2011, analyzing the methodologies used in air cargo volume forecasts and air cargo operations forecasts.

For air cargo volume forecasts, the master plans primarily used traditional methodologies dependent upon statistical models and factors such as the airport's historic air cargo volumes (time series), and global, national, and local air cargo, as well as socioeconomic trends and forecasts. However, four master plans used market share approaches or probabilistic forecasting.

A minimal number of airport master plans used unique approaches to forecasting air cargo aircraft operations. As described in this section's earlier methodology briefs, standard techniques involved consideration of historical air cargo tonnage per aircraft operation, existing and future aircraft sizes, as well as global and national forecasts prepared by Boeing, Airbus, and the FAA.

Among the rare exceptions, one airport (FedEx western regional hub Oakland) used a methodology that involved development of average annual day cargo schedules and another used probabilistic forecasting.

RISK ASSESSMENT

Rarely have risks been more obvious than in recent years when air cargo forecasts have routinely diverged dramatically from actual results. Not only was the collapse of the last decade relatively unforeseen but analysts have repeatedly misidentified what was perceived as the low point of the industry recession.

Consequently, the usefulness of a conventional time series (trend analysis) has been greatly compromised as a predictor. Time series can also be wildly skewed by anomalies at either the start or finish year of the historical period under review.

Econometric modeling also requires faith that the past is a reliable indicator of the future activity, typically linking historical relationships between cargo growth rates and other economic variables. Typically, such models assume unconstrained capacity but the ability of airlines to shift between modes and service points greatly undercuts the reliability of that assumption.

Using institutional forecasts such as those of Airbus, Boeing and the FAA to calibrate local growth rates is certainly defensible. However, each of those forecasts is national in scope while the U.S. is comprised of individual markets that have tended to not move in economic lock-step.

Because air cargo operations are typically derived from tonnage forecasts, any inaccuracies in the latter will carry through the former. In addition to all of the preceding, cargo forecasts could be dramatically affected for the negative by increased diversion of intercontinental cargo from air to ocean transport, as well as any acceleration of the recent mass migration of domestic cargo from air to trucks. Cargo operations may also be affected by spikes in fuel prices that could make freighters more challenging to operate profitably, while a decrease in fuel prices may cause carriers to resurrect freighters that have been parked due to fuel inefficiency but which still had utility otherwise.

ACRP Report 76 (ACRP 03-22), "Addressing Uncertainty about Future Airport Activity Levels in Airport Decision Making", completed in June 2012, provided a guidebook and systems analysis methodology to (1) identify and characterize risks and opportunities; and (2) enable airport management to address risks and opportunities in their business models.

FACILITY REQUIREMENTS: AIR CARGO APRON

The role of the air cargo apron is to provide aircraft parking adjacent to the air cargo terminal building; to provide sufficient space for ground handling operations for the loading and unloading of cargo aircraft as well as service the aircraft; and to provide sufficient space for the storage of Ground support Equipment (GSE) as well as ULD and pallet storage. For operations at international gateways and origin and destination domestic markets the space must be large enough to park an optimal number of aircraft, as well as to accommodate aircraft tugs, cargo containers and trailers, cargo vehicles, mobile stairs, tail stands, and fueling vehicles or carts. For airports supporting integrated express hubs the apron would include all the aforementioned attributes plus provide space for cargo sortation, large 53' tractor trailers as well as space for tail to tail cargo transfer and bypass containers.

Some cargo aprons contain fixed equipment that includes cargo loading platforms and in-ground nose tethers. The air cargo apron must be relatively level and provide access to the airports taxiway system and should be in close proximity to the airport's runways in order to reduce taxi times. Some air cargo aprons may be located on areas of the airport without adjacent terminal warehouses but this is the exception and not the rule.

Since large cargo aircraft will be parking on the apron the asphalt or concrete pad supporting these large aircraft must provide sufficient strength to support these aircraft. Aircraft parking areas, also called "hard stands", typically have weight bearing strength greater than the taxiway system since aircraft will be positioned on these for longer periods of time. Hard stands are designed differently than taxiways since they require greater steel reinforcement and more stringent expansion joint systems. Hard stands need to be designed by aircraft type, which take into consideration gear spacing and number of wheels, and; therefore' the aircraft type that are anticipated to operate in the cargo area need to be accurately forecasted by the airport planner.

Aircraft Types

There are three major kinds of aircraft that operate on air cargo aprons and serve as air freighters, these include: wide-body jets, narrow-body jets, and narrow-body turboprop aircraft which commonly function as feeder aircraft. A significant amount of freighters in service today are converted passenger aircraft that have reached the end of their service life as passenger carriers (Figure 9-12 - 9-15). Other freighters, particularly wide-body freighters, are manufactured as such by Boeing and Airbus. The converted freighters tend to be significantly older, less fuel efficient, and, given their age, are more susceptible to maintenance problems than their passenger carrier counterparts and recently manufactured freighters. Freighters operating on airports in the U.S. are used by integrated express carriers on domestic and international routes and by all-cargo carriers on international North Atlantic and Pacific routes. These wide-body freighter aircraft can operate with payloads ranging from 80,000 to 234,000 pounds. The exception to this is the DC-8 which is a narrow body transoceanic aircraft.

As stated previously, international air cargo travels in the baggage compartment, or lower deck, of passenger aircraft; this cargo is also referred to as "belly cargo." The wide-body aircraft that typically serve these routes offer substantial freight capacity. This capacity is increasing with the next generation of aircraft. For example, the Airbus A330/340 passenger aircraft have much greater cargo capacity per available seat than their predecessors, offering space for up to 32 lower deck containers. Pure freighters utilize both main deck (normally the passenger area) and lower deck positions ("baggage compartments") for freight carriage.

Narrow-body jet aircraft are typically used for short haul domestic routes, while feeder aircraft serve small market needs. Narrow body aircraft payloads range from 18,000 pounds to 95,000 pounds. Feeder aircraft payloads can range from 2,000 to 10,000 pounds. Upper decks on narrow-body aircraft accommodate containers, while the lower deck is bulk loaded in a process where individual pieces of freight are placed directly into the aircraft without the benefit of containers. Feeder aircraft are typically bulk loaded only.

Figure 9-12 Wide Body Freighter Sample, Boeing 777-200. (SOURCE: Boeing Aircraft Characteristics for Airport Planning.)

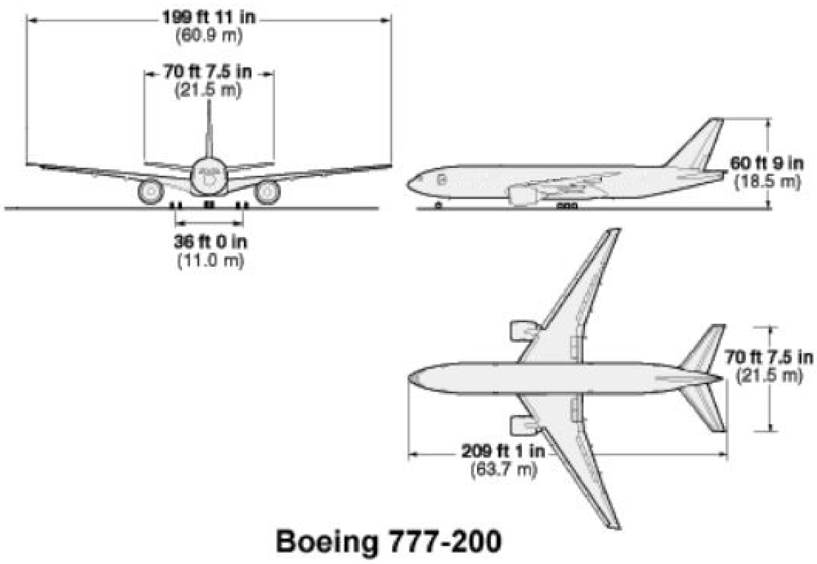


Figure 9-13 Wide Body Freighter Sample, Airbus A300-600. (SOURCE: Airbus 3-view Aircraft Drawings.)

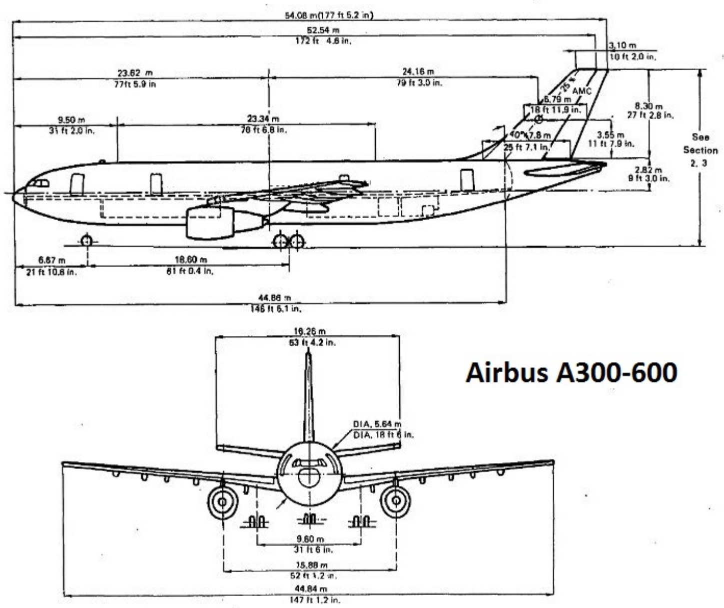


Figure 9-14 Narrow Body Freighter Sample, Boeing 757. (SOURCE: Boeing Aircraft Characteristics for Airport Planning.)

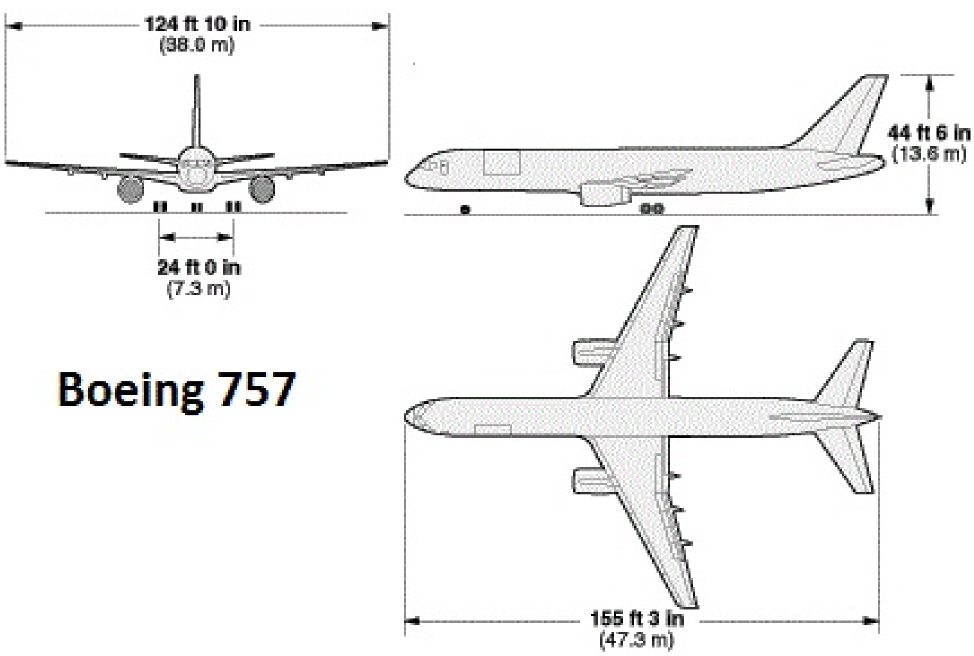
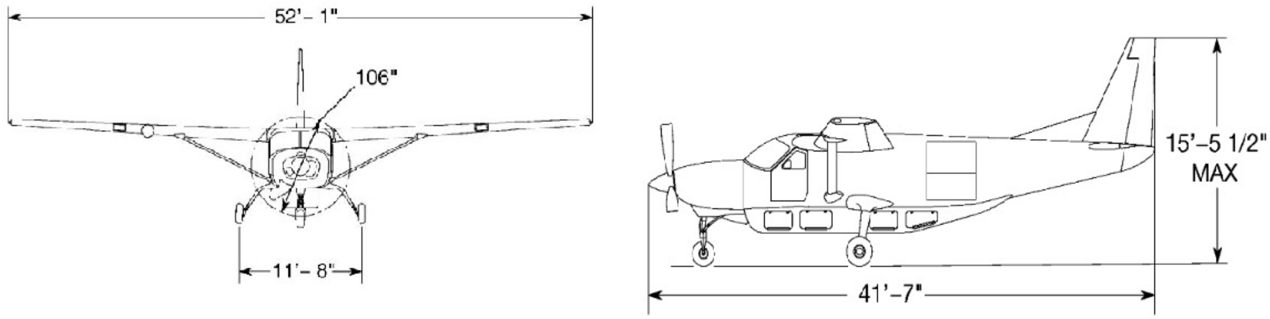


Figure 9-15 Regional Air Cargo Feeder Aircraft Sample, Cessna Caravan 208B. (SOURCE: Cessna Information Manual.)

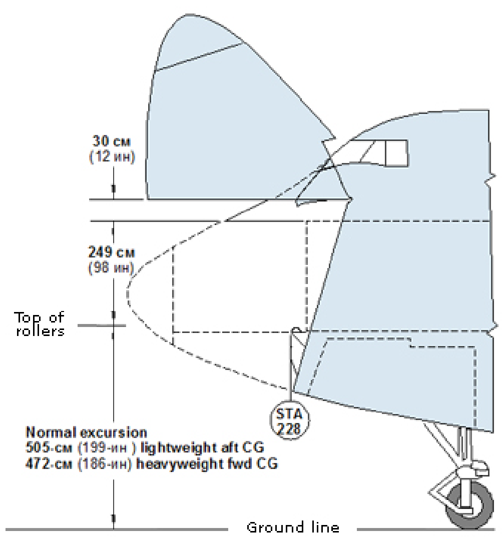


Cessna Caravan 208B

Perhaps one the most unique attributes of widebody and narrowbody aircraft is their ability to accommodate containers and unit load devices (ULDs) and pallets. These aircraft have large doors and rollers fastened to the deck of the aircraft. These aircraft allow containers and pallets laden with freight and mail to be rolled on and off aircraft either manually or electronically (Figure 9-16).

Cargo aircraft are generally equipped with one large door on the port side of the aircraft on the upper deck and two (baggage compartment) doors on the starboard side of the lower deck. Some cargo aircraft are loaded through an opening at the front of the aircraft, which is revealed when the nose is lifted. Cargo aircraft with nose-loading capabilities can accommodate large items that do not fit through side cargo door openings. Tandem ULD and pallet loading operations for aircraft with both a nose door and side door on the main deck can expedite the loading process thereby reducing aircraft turn-times.

Figure 9-16 Boeing 747 Cargo Nose Door Profile. (SOURCE: Boeing Aircraft Characteristics for Airport Planning.)



Some freight terminals have fixed nose-dock loading systems which will be discussed in greater detail in a subsequent section. These allow nose-loading aircraft to load directly from the Elevated Transfer Vehicle (ETV) system through the open nose of the aircraft, which is parked immediately adjacent to the system. Other loading systems for the nose door include mobile K Loaders.

CRITICAL AIRCRAFT IMPLICATIONS TO APRON

The development of airport facilities is impacted by both the demand for those facilities, typically represented by total based aircraft and operations at an airport, as well as the type of aircraft that will make use of those facilities. In general, airport infrastructure components are designed to accommodate the largest and/or most demanding type of aircraft, referred to as the critical aircraft, expected to use the infrastructure on a regular basis (at least 500 annual operations). Once the critical aircraft has been identified, its approach speed and wingspan are used to characterize the runway design standards and specifications required for an airport to safely and effectively serve that aircraft.

The FAA groups aircraft into Aircraft Categories and Airplane Design Groups (ADG) based on their approach speed and wingspan, respectively. The criteria for these categories are presented in Tables 9-2 and 9-3.

Table 9-2 Aircraft Categories.

Aircraft Category	Approach Speed	Typical Aircraft
A	< 91 knots	Cessna 172
B	91 to < 121 knots	Cessna Citation III
C	121 to < 141 knots	CRJ, Lear 25
D	141 to < 166 knots	Airbus A380, Boeing 747
E	166 knots or more	Future Aircraft

SOURCE: FAA Advisory Circular 5300/13

Table 9-3 Airplane Design Groups.

Airplane Design Group	Wingspan	Typical Aircraft
I	< 49 feet	Cessna 172, Cessna 401
II	49 to < 79 feet	Falcon 50, Gulfstream III
III	79 to < 118 feet	B-727, B-737, DC-9
IV	118 to < 171 feet	A-300, B-757, B-767, DC-10
V	171 to < 197 feet	B-747
VI	197 to < 262 feet	A380, B747-8

SOURCE: FAA Advisory Circular 5300/13

After identifying an airport's critical aircraft it is then possible to determine the Airport Reference Code (ARC). The ARC is a coding system that relates airport design criteria to the operational and physical characteristics of the airplanes that are intended to operate at an airport. An ARC is a composite designation based on the Aircraft Category and Airplane Design Group of the critical aircraft.

Critical aircraft not only govern the size of the runway design but also govern the design of the taxiway system and apron and other pavements strength and parking dimensions. For commercial service airports critical aircraft are typically large passenger aircraft serving the airport but it is not unusual for a specific cargo aircraft operating on a scheduled basis to be the critical aircraft. For example, at Indianapolis International Airport the largest passenger aircraft serving the airport is the B737-800 while the largest cargo aircraft operating at the airfield on a scheduled basis is CargoLux' B747-400. This aircraft may be upgraded to the B747-8 in the near future.

ROLE OF AIRCRAFT MANUFACTURERS IN AIRPORT MASTER PLANNING

Space for large cargo aircraft parking, hardstand usage, ground operations, and runways is best measured against the needs of the specific cargo aircraft being accommodated rather than forecasted tonnage throughput. It is at this point in the planning process that airport planners work most closely with the airlines and airplane manufacturers.

For example, Boeing produces airport-planning manuals, titled Airplane Characteristics for Airport Planning, for all Boeing and Douglas-designed commercial airplanes. These manuals describe specific airplane characteristics, such as dimensions, performance, ground maneuvering, terminal servicing, jet-engine wake and noise, and pavement requirements. Airbus has a similar airport planning manual for its family of aircraft. These manuals provide information on basic airplane runway-length requirements, performance, typical interiors, pavement requirements, and jet blast attributes. The Boeing Airplane Characteristics for Airport Planning manuals, are made available by the manufacturer for any transport-category airplane having maximum takeoff weights of 35,000 lb. (15,875 kg) or more.

Airlines, airports, and airplane manufacturers together walk a fine line, balancing the desire for increased airplane capacity, range, and operating economy with the need for airport improvements and modifications.

CARGO APRON AIRCRAFT SPACE REQUIREMENTS

Cargo aircraft are commonly parked adjacent to the air cargo terminal building at 90 degrees or on a diagonal to the building. There are instances where the cargo apron is designed to park the aircraft parallel to the building but straight in at 90 degrees perpendicular is the most typical configuration. The aircraft should be parked as near as possible to the freight terminal in order to reduce the amount ground traffic movement. The distance between the nose of the aircraft and the terminal exterior wall varies depending on the size of the aircraft and whether the cargo aircraft has a nose-loading door.

Airport planners must consider the entire fleet of aircraft planned to use the cargo apron, and any equipment that may need to operate in front of the aircraft. Sufficient length and maneuvering space must be available for aircraft tugs and towbarless tractors, which is dependent on the position of the nose gear relative to the aircraft nose. Also, sufficient space must be provided for loading equipment operating in front of a nose-loaded cargo aircraft and clearance for the nosecone in the upright position. Defining the minimum distance between the aircraft nose and a structure or other barrier is critical to ensuring that adequate apron depth is provided to fully accommodate parked aircraft within the apron area.

Adequate separation is needed between the wingtips of aircraft occupying adjacent parking positions, as well as between wingtips and any fixed or movable object. The cargo aircraft parking apron requirement should be calculated based on the number of aircraft that are projected to be simultaneously parked on the apron, and using the wingspan sizes of the aircraft types projected in the air cargo fleet mix along with allowances for wingtip clearances (25 feet between aircraft and objects). Table 9-4 provides separation distances from the aircraft nose to the rear wall of the terminal building as well as separation distances from aircraft wingtips and service roads. It is common to provide 5 feet of clearance between the wingtip of a parked aircraft and the edge of the marked service road to protect against vehicles that may deviate from the marked roadway. As noted in *ACRP Report 96, Apron Planning and Design Guidebook*, the FAA recommends minimum nose-to-building distances of 15 feet for ADG III aircraft, 20 feet for ADG IV aircraft, and 30 feet for ADG V aircraft for passenger aircraft but cargo aircraft require larger buffers.

Table 9-4 Aircraft-Building Separation Distances.

Aircraft Design Group	III to VI	Nose Door Aircraft
Minimum Nose to Structure Distance in Linear Feet	55	80
Minimum Wingtip to Object Distance in Linear Feet	25	25
Minimum Wingtip and Tail to Service Lane Distance in Linear Feet	5	5
Minimum Tail to Taxi-lane Edge in Linear Feet	75	75

SOURCE: CDM Smith.

Another factor to be considered by airport planners is that in planning/designing new aprons as well as modifying existing aprons one needs to take into account blended wing and winglet technology which adds to the length of an aircraft' wingspan. Blended wing technology is available as a retrofit to an existing aircraft fleet and as an option on new aircraft.

Airport planners must be aware of the variety of cargo aircraft operating on a scheduled basis at airports throughout the U.S. Table 9-5 provides a list of cargo jet aircraft typically operating at U.S. airports on a scheduled basis as well as each aircraft's FAA Aircraft Design Group (ADG) which categorizes aircraft by wingspan and the FAA's Aircraft Approach Category (AAC) which categorizes aircraft by approach speed when landing. Aircraft in the A category approach the runway at much slower speeds than aircraft in the D category. Table 9-5 takes only into consideration all cargo aircraft and does not include passenger aircraft.

When planning for cargo apron space the airport planner basically has two methods for determining the amount of cargo apron space needed. The planner can utilize a throughput metric based on tonnage handled on the ramp on an annual basis or on a peak period basis. The planner can ascertain from the airport's cargo carriers their anticipated aircraft types which are likely to operate on the airfield during the planning period. A typical master plan requires at least a 20 year planning period for facilities while an air cargo carrier typically plans its fleet on five- to ten-year increments. Planners may also be required to modify or reconfigure existing cargo ramp space to support a cargo carrier when a change in aircraft types is imminent. While this prospect does not directly involve master planning it falls into the airport planners day-to-day planning responsibilities. Table 9-6 provides the airport planner a useful tool in determining the amount of space required for cargo aircraft parking. The total space required per aircraft type takes into consideration the aircraft's wingspan as well as overall length. Buffer space is also included in the total square footage requirements to separate aircraft from other aircraft as well as buildings and service lanes. Buffer allows space for aircraft service and GSE storage and utilization. While the FAA does not specify cargo apron design standards, ACI and A4A do provide apron facility guidelines. *ACRP Report 96* provides guidelines on apron planning but is primarily focused on airline terminal apron areas. Aircraft tail height is provided to assist in determining line of sight issues as well as potential airspace penetration issues. Planners should allow 25 linear feet between aircraft wing tips when designing aircraft parking positions on the apron as well as sufficient distance between the nose of the aircraft and any structures. Table 9-6 includes the recommended distances based on ADG presented in Table 9-5.

Table 9-5 Representative Sample of Cargo Jet Aircraft and Carriers Operating at U.S. Airports.

Jet Cargo Aircraft	AAC	ADG	FedEx Express	UPS	ABX	American Transp. Int'l	Southern Air	Amerijet	Centurion Air Cargo	ATLAS	Polar Air Cargo	CargoLux	Avianca	Korean Air	Cathay Pacific
Airbus A300-600	C	IV	✈	✈											
Airbus A310-200	C	IV	✈												
Airbus A310-300	C	IV	✈												
Airbus A330-200F*	C	V											✈		
Boeing 727-200*	C	III						✈							
Boeing 747-200	D	V							✈						
Boeing 747-400*	D	V		✈			✈			✈	✈	✈		✈	✈
Boeing 747-400ERF	D	V													✈
Boeing 747-8	D	VI								✈	✈	✈		✈	✈
Boeing 737-700C*	C	III													
Boeing 757-200	C	IV	✈	✈		✈									
Boeing 767-200	C	IV			✈	✈		✈		✈			✈		
Boeing 767-300F	D	IV	✈	✈	✈	✈				✈			✈		
Boeing 777-200	C	V	✈				✈								
Douglas DC-8-70	C	IV				✈									
McDonnell-Douglas MD-10	D	IV	✈												
McDonnell-Douglas MD-11	D	IV	✈	✈					✈						

*includes winglets.

SOURCE: FAA AC15/5300, Carrier websites.

NOTE: ABX, American Transport International and Southern Air contract extensively to DHL.

Table 9-6 Space Requirements for Cargo Jet Aircraft Operating at U.S. Airports.

Common Jet Cargo Aircraft	AAC	ADG	Length	Wing Span	Tail Height	Length Including Nose/Tail Buffers	Wingspan + 25'	Total Area in ft^2
Airbus A300-600	C	IV	177.0	147.1	55.0	307.0	172.1	52,834.7
Airbus A310-200	C	IV	153.1	144.0	52.1	283.1	169.0	47,843.9
Airbus A310-300	C	IV	153.1	144.0	52.1	283.1	169.0	47,843.9
Airbus A330-200F*^	C	V	191.5	197.8	57.1	321.5	222.8	71,630.2
Boeing 727-200*	C	III	153.2	109.3	34.9	283.2	134.3	38,033.8
Boeing 747-200^	D	V	229.2	195.8	64.3	359.2	220.8	79,311.4
Boeing 747-400*^	D	V	231.9	213.0	64.0	361.9	238.0	86,132.2
Boeing 747-400ERF^	D	V	232.0	212.9	64.3	362.0	237.9	86,119.8
Boeing 747-8^	D	VI	250.2	224.4	62.7	380.2	249.4	94,821.9
Boeing 737-700C*	C	III	110.2	117.5	41.7	240.2	142.5	34,228.5
Boeing 757-200	C	IV	155.2	125.0	45.1	285.2	150.0	42,780.0
Boeing 767-200	C	IV	159.1	156.2	52.9	289.1	181.2	52,384.9
Boeing 767-300F	D	IV	180.1	156.2	52.6	310.1	181.2	56,190.1
Boeing 777-200	C	V	209.0	199.8	61.5	339.0	224.8	76,207.2
Douglas DC-8-70	C	IV	187.3	148.3	43.3	317.3	173.3	54,988.1
McDonnell-Douglas MD-10	D	IV	183.0	165.0	58.8	313.0	190.0	59,470.0
McDonnell-Douglas MD-11	D	IV	202.1	170.5	58.8	332.1	195.5	64,925.6

*includes winglets, ^assumes nose door aircraft. SOURCE: FAA AC15/5300, Carrier websites.

Turboprop aircraft are also used to transport air cargo on a scheduled basis. The majority of these operations are related to regional cargo aircraft which feed cargo to awaiting integrated express cargo jets. In some instances these aircraft fly directly to an integrated express cargo hub. Table 9-7 identifies turboprop cargo aircraft, their AAC and ADG category, and carriers that currently operate these aircraft for cargo operations. It is noteworthy to point out that these aircraft may be located on an integrated express origin and destination station which are supported by the carriers staff;; or these facilities may have a small cargo shed or hangar and a tie down spot on the air cargo apron. These aircraft may also be solely supported by the airport's Fixed Base Operator (FBO) and resultantly rely on the FBO staff to load and fuel the aircraft. These operations often take place on the general aviation apron and blend in with the other general aviation traffic. An integrated express operator would likely drive their truck(s) to the aircraft for loading and unloading. Many of the regional cargo aircraft are contracted carriers and their aircraft may or may not be painted in the client's logo and paint scheme. Mountain Air Cargo for example is a contractor to FedEx Express and flies C208 aircraft with FedEx branding on the aircraft. Where regional cargo aircraft feed into the cargo jet the apron area may have parking positions for large cargo jets and several turboprop feeder aircraft.

Table 9-7 Regional Turboprop Cargo Aircraft/Carriers Operating at U.S. Airports.

Common Cargo Turbo Prop	AAC	ADG	Wiggins	Empire	Mountain Air Cargo	Ameriflight	Air Cargo Carriers	Alpine Air
ATR42	B	III	✈	✈	✈			
ATR72	B	III	✈	✈	✈			
B1900	B	II				✈		✈
Beech B99/C99	B	I				✈		✈
Cessna Caravan 208	B	II	✈	✈	✈			
DeHavilland DASH 8	A	III						
EMB-120	B	II				✈		
Fairchild Dornier SA-227DC	B	III				✈		
Metroliner III	B	I				✈		
SHORT SD3-60	B	II			✈	✈	✈	

SOURCE: FAA AC15/5300, Carrier websites.

Table 9-8 provides the airport planner a useful tool in determining the amount of space required for regional cargo aircraft parking. The total space required per aircraft type takes into consideration the aircraft's wingspan as well as overall length. A 12.5 foot buffer space is also included in the total square footage requirements to separate aircraft from other aircraft as well as buildings. This area provides sufficient space for aircraft parking and servicing and loading the aircraft. Planners should allow 25 linear feet between aircraft wing tips and sufficient distance between the nose of the aircraft and any structures.

Table 9-8 Space Requirements for Regional Turboprop Cargo Aircraft Operating at U.S. Airports.

Common Cargo Turbo Prop	AAC	ADG	Length	Wing Span	Tail Height	Length Including Nose/Tail Buffers	Wingspan + 25'	Total Area in ft^2
ATR42	B	III	74.5	80.6	24.9	109.5	105.6	11,563.2
ATR72	B	III	89.2	88.8	25.0	124.2	113.8	14,127.8
Beech B1900	B	II	57.9	58.0	15.5	82.9	83.0	6,880.7
Beech B99/C99	B	I	45.0	45.9	14.3	70.0	70.9	4,964.4
Cessna Caravan 208	B	II	42.0	52.1	14.8	67.0	77.1	5,165.7
DeHavilland DASH 8	A	III	84.3	89.9	24.1	119.3	114.9	13,707.6
EMB-120	B	II	65.6	65.0	20.9	90.6	90.0	8,154.0
Fairchild Dornier SA-227DC	B	III	59.3	95.2	27.5	94.3	120.2	11,334.9
Metroliner III	B	I	59.5	46.2	16.7	84.5	71.2	6,016.4
SHORT SD3-60	B	II	70.7	74.8	23.1	95.7	99.8	9,550.9

SOURCE: FAA AC15/5300, Carrier websites.

UTILIZING FACILITY PLANNING METRICS FOR CARGO APRON DESIGN

Air cargo facility utilization data was analyzed based on 31 air cargo facility survey data for apron area, warehouse space, GSE storage and truck/auto parking. Airports were analyzed in this study to estimate the annual ton per square footage utilization of air cargo for warehouse ramp space, and GSE storage space. Truck and automobile parking facility development is based on warehouse size. Table 9.9 provides a facility requirements data matrix of ratios for the following cargo facilities based on cargo operator type, which include:

- Integrated express carriers
- Third party providers/All cargo carriers

Dedicated cargo apron space for passenger carriers is not presented since most passenger carrier facilities do not have a need for designated air cargo ramp area to park aircraft since cargo for passenger carriers is typically tugged to the aircraft parked at the passenger terminal ramp. It is important to point out that these ratios are generic in nature to provide high level guidance for air cargo area facility planning and are not typically applicable to individual carrier practices which will likely have substantial variations in space requirements. These ratios, however, provide capacity requirements for air cargo activity on an airport. Carrier specific utilization data should be obtained during the inventory process.

Ramp Throughput Analysis – Ramp throughput rates are the standard measures to define the capacity of freight facilities, and this rate is expressed in annual ton of freight per square foot of ramp. Airport master plans use several methods for determining ramp space. For example, according to the San Diego International Airport MP, one accepted planning criterion for cargo apron is to allow five ft^2 of apron per square foot of cargo building space. Another method is to utilize an average area per aircraft based on the fleet mix in the master plan cargo forecast. These parking areas incorporate standard wingtip clearances and allow room for GSE, as well as room for a taxi-lane to service the area. Both these ratios however often include ramp utilized for both aircraft parking and GSE storage and operating space.

Integrated Express Aircraft Parking Apron – This analysis provides airport planners ratios for determining space requirements for both Aircraft Parking and GSE Storage for a combined air cargo apron planning metric. These ratios are based on survey data from an extensive data collection effort. As presented in Table 9-9, cargo aircraft parking space utilization based on annual cargo tonnage throughput arrives at approximately 0.19 annual tons per square foot for domestic cargo for integrated express carriers and 0.19 for the same carrier type at international gateway airports. Ratios for ground support equipment, or GSE, is typically not broken out in a master plan facility requirements but is provided here. Cargo ramp or apron facility requirements in a typical master plan combine aircraft parking ramp areas and GSE storage areas. Since the data collection effort focused on data related to GSE spatial needs this analysis provides GSE space ratios for integrated express carriers.

Table 9-9 Air Cargo Facility Requirements Ratio Matrix.

	Integrated Express	Pax Belly	Third Party Providers & All Cargo Carriers
Warehouse			
Domestic	0.92	0.22	0.81
International Gateway	0.37	0.33	0.81
Master Plan Review Ratios*	0.93	0.63	0.57
Ramp			
Domestic	0.19		0.16
International Gateway	0.19		0.91
GSE Storage			
General	0.57	0.36	1.11

SOURCE: CDM Smith, *various airport master plans from Literature Review.

Integrated Express GSE Storage Apron – The weighted average analysis related to Average Ton per Square Foot for integrated express carriers GSE storage requirements, located on both international gateway and domestic airports, arrives at 0.57 annual ton per square foot.

Applying the GSE Storage and Aircraft Parking Ratios

The Air Cargo Facility Requirements Ratio Matrix provides the metrics for converting annual cargo tonnage flows into cargo aircraft parking and GSE storage area requirements. Simplified calculations based on empirical data from this study's research can assist in providing an order of magnitude of the air cargo apron requirements, in a preliminary design stage. For example, the size of the apron area required for the typical cargo volume can be calculated by dividing the annual cargo volume by the throughput per unit apron area. This methodology can be applied to current conditions on the airport as well as forecasted air cargo tonnage. The representative, or indicative, value is based on a series of measurements and is the one which is closest to the real value of the said measurement. If one carries a series of measurements, the representative value will be their average, excluding those outlier values which have proved to be far from the true value. Representative values, based on research and analysis, for an integrated express O&D station aircraft parking is .19 U.S. Ton/square feet per year for the U.S. domestic and international operations while for GSE storage it is .57 U.S. Ton/square feet per year. For example, if an airport had an integrated air express tenant moving 80,000 U.S. tons annually it would require 413,600 ft^2 (9.5 acres) of apron space to accommodate their aircraft operations (Table 9-10). For the same amount of cargo volume an additional 139,200 ft^2 of apron space for GSE would be needed. Combining the two requirements results in 552,800 ft^2 (12.7 acres) of apron to accommodate the 80,000 annual tons. It is noteworthy to point out that the integrated express industry operates on average 5.5 days per week. 80,000 annual tons then translates to approximately 559,400 pounds of inbound and outbound cargo per day or about eight fully loaded B757s (inbound and outbound).

Table 9-10 also provides metrics for converting annual cargo tonnage flows into cargo aircraft parking and GSE storage area requirements for third party handlers and all-cargo carriers. Representative values for an all-cargo freighter station aircraft parking is .91 U.S. Ton/square feet per year for the U.S. international operations while for GSE storage it is 1.11 U.S. Ton/square feet per year. For example, if an airport had an all-cargo carrier tenant moving 80,000 U.S. tons annually it would require 97,912 ft^2 (2.0 acres) of apron space to accommodate their aircraft operations (Table 9-11). For the same amount of cargo volume an additional 72,000 ft^2 of apron space would be needed for GSE storage. When combining the two requirements it results in approximately 159,900 ft^2 (3.7 acres) of apron to accommodate the 80,000 annual tons.

Table 9-10 Air Cargo Facility Requirements Ratio Application: Integrators.

Integrated Express Carrier	Annual Tonnage	Ton/ft^2 Ratio			Apron Required in Square Feet	Apron Required in Square Yards	Apron Required in Acres
Apron	80,000	/	0.19	=	413,600	45,956	9.5
GSE Storage	80,000	/	0.57	=	139,200	15,467	3.2
Total					**552,800**	**61,422**	**12.7**

SOURCE: CDM Smith.

While passenger airlines do not have air cargo apron requirements related to parking of cargo aircraft they do have pavement requirements related to the operations adjacent to their air cargo terminal facilities. Representative values for an air cargo terminal apron for passenger airlines is 0.36 U.S. Ton/square feet per year for the U.S. If a passenger airline terminal is moving 10,000 tons per year would require 27,777 ft^2 of paved space (10,000/.36) to accommodate tugs and cargo trains.

Table 9-11 Air Cargo Facility Requirements Ratio Application: Freighters.

Integrated Express Carrier	Annual Tonnage	Ton/ft^2 Ratio			Apron Required in Square Feet	Apron Required in Square Yards	Apron Required in Acres
Apron	80,000	/	0.91	=	87,912	9,767	2
GSE Storage	80,000	/	0.11	=	72,000	8,000	1.7
Total					**159,912**	**17,767**	**3.7**

SOURCE: CDM Smith.

An important factor for airport planners need to take into consideration, related to the cargo tonnage throughput methodology, is the industry practice of air cargo carriers sharing one aircraft to serve two markets. For example, UPS operates an Omaha-Cedar Rapids-Louisville route with a B757-200 aircraft yet the Cedar Rapids station may only be allotted 30% of the capacity. When aircraft are shared in these types of situations the annual volume does not necessarily translate into a corresponding ramp size. In other words, the aircraft serving the market may be larger than the market demands and thereby require a larger apron area than one would expect. That is why it is important for airport planners to interview the key cargo stakeholders in order to better understand their needs and plans for aircraft equipment anticipated to operate in the market.

Several practices with in the industry also impact the amount of space needed for aircraft parking. For one, many integrated express operators park their aircraft during the day on the apron at spoke airports and fly to their respective hubs at night where packages are sorted. But it is not unusual for integrators to only stop an aircraft in a market then fly on to its final destination where it remains parked all day. The airport planner then must take into consideration the peak hour of demand for cargo aircraft parking. In Casper, Wyoming for example, FedEx Express schedules two B757s which arrive from the Memphis hub but one continues on to Grand Junction, Colorado and the other to Boise, Idaho. In addition, FedEx operates about six Cessna 208 feeder flights into the airport. All these operations require considerable apron space for an airport with a relatively small market area. Also at Casper, UPS operates a single contracted Metro III aircraft which is supported by the airport's FBO and requires limited space on the general aviation ramp.

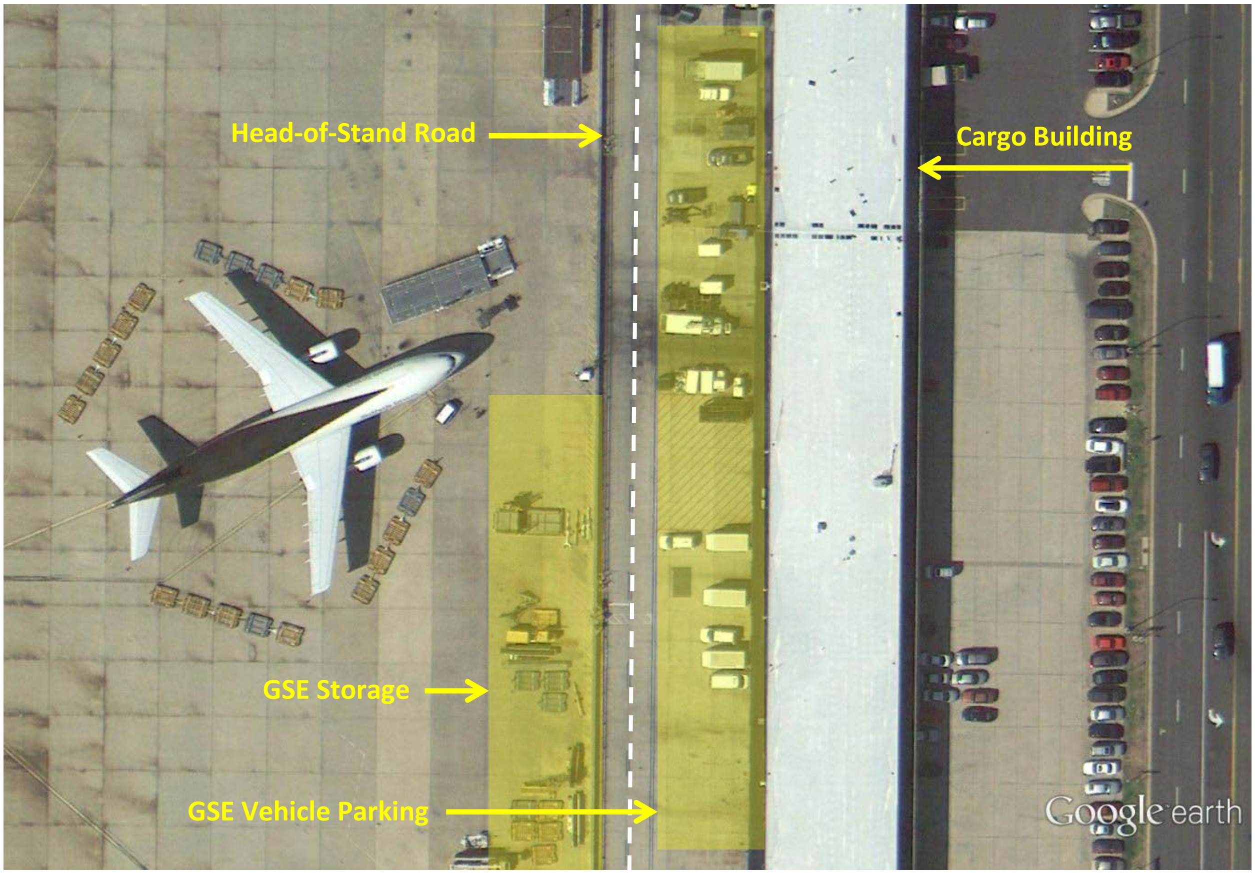
All-cargo freighter businesses may also share aircraft with airports in other markets. For example, Kallita Air Cargo operates a B747-400 from Hong Kong to Rickenbacker International in Columbus, Ohio then ferries empty over to JFK International where it is loaded with backhaul to Hong Kong. Tonnage on this route then is only reflective of inbound cargo. These types of nuances within the industry may not necessarily translate well when applying the Air Cargo Facility Requirements Ratio Matrix and emphasizes the importance of the airport planner's understanding of industry practices on their airport.

CARGO APRON DESIGN CONSIDERATIONS

Apron service roads serve as the main vehicle circulation arteries in and around the air cargo terminal core and other apron facilities. The purpose of apron service roads is to channelize the movement of air cargo related vehicles so that pilots know where these vehicles are and to prevent conflicts with aircraft or engine jet blast.

Head-of-Stand Road – A head-of-stand road is located between the nose of the parked aircraft and a cargo building. This configuration allows for uninterrupted access to aircraft as vehicle movements are not stopped for aircraft entering or exiting a gate. With this configuration, vehicles and GSE can travel from storage/staging areas around the gate areas directly to aircraft for servicing without accessing taxiways or taxilanes, having to wait for aircraft pushing back or pulling into a gate position, or other potential interactions. Head-of-stand road alignments also tend to increase apron depth and require additional PLB segments. Figure 9-17 provides an example head-of-stand road at the UPS cargo ramp at Dulles International Airport. It is noteworthy top point out that head-of-stand roads require apron dimensions with greater depth, especially to accommodate aircraft tugs without interfering with vehicle movements on these roads. These roads may create conflicts with apron level cargo terminal door exits for personnel and ground vehicles. Overall, the head-of-stand configuration enhances safety by limiting interactions between vehicles and moving aircraft.

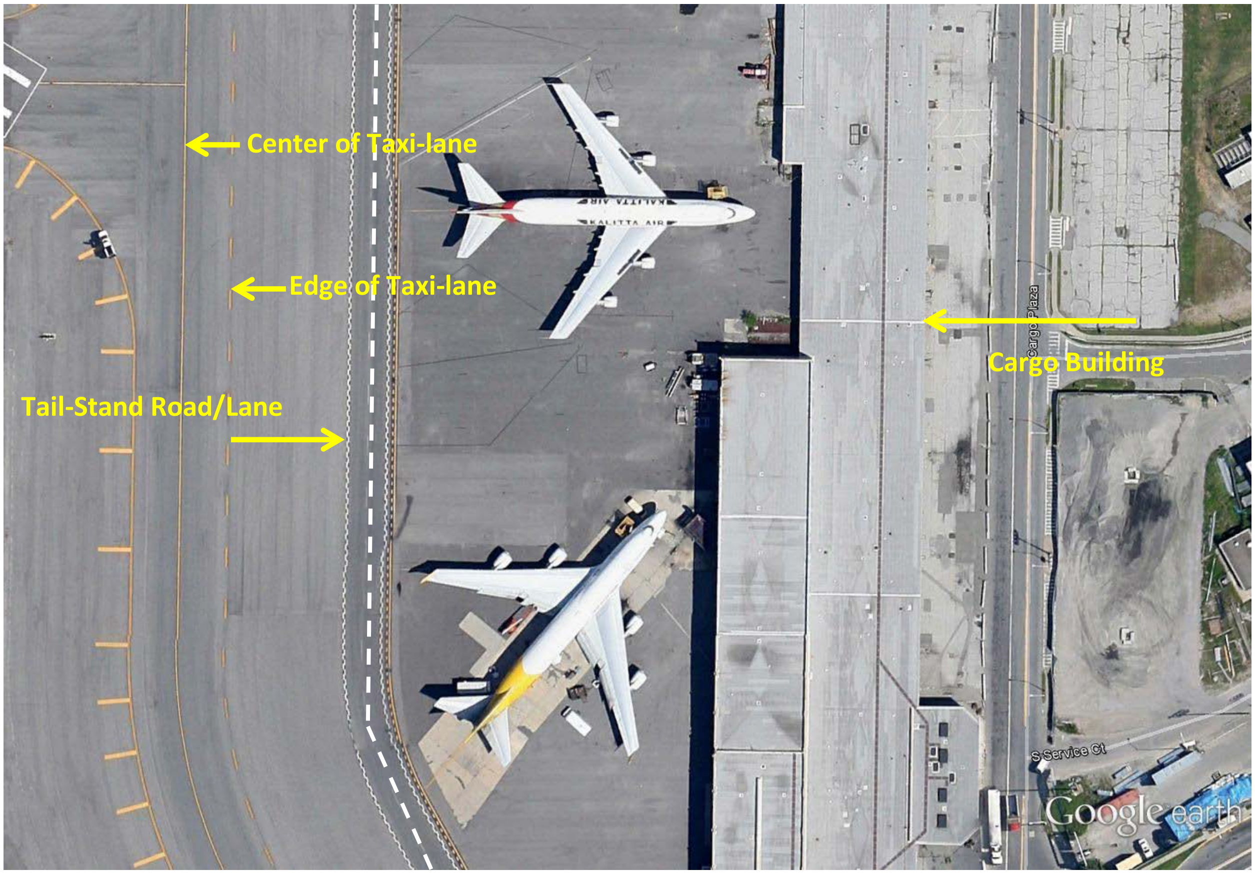
Figure 9-17 Head-of-Stand Road and GSE Storage Configuration. (SOURCE: Google Earth Pro, CDM Smith Analysis.)



Tail-Stand Road – A tail-stand road is located at the tail of the aircraft, at times referred to as an apron edge service road because the road can delineate the limit of the leased areas. As shown on Figure 9-18, the layout of this type of service road usually reflects the physical limits of aircraft parking areas, out may also reflect the taxiway/taxilane alignment. Tail-stand roads can result in potential conflicts between vehicles and aircraft, as aircraft must cross the tail-stand roads to enter or exit gates. Figure 9-15 provides an example tail-stand road at the DHL cargo ramp at JFK International Airport.

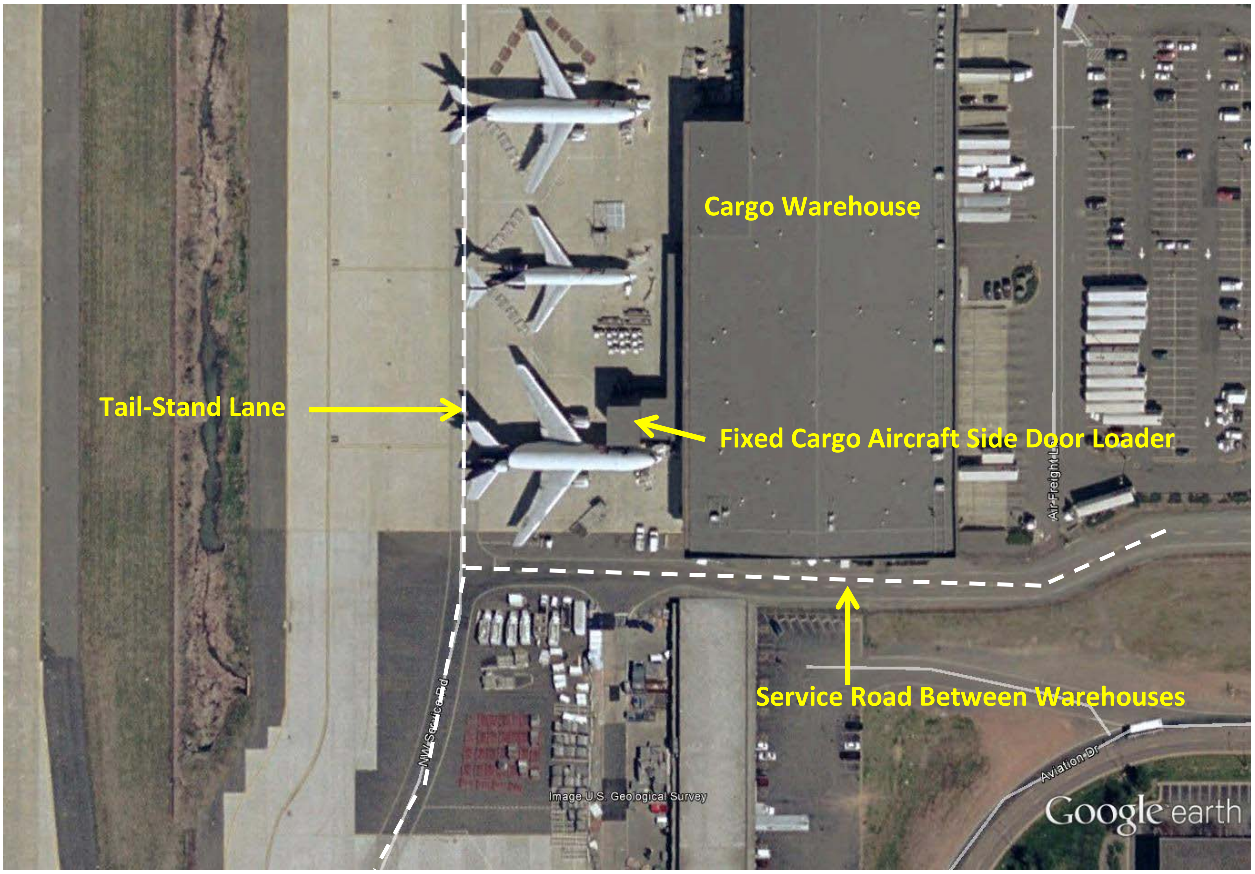
To avoid operational consequences, tail-stand service roads must be located outside all taxiway and taxilane object free areas (OFAs), as penetrations of these areas can result in limitations on the size of aircraft that can use the affected taxiways/taxilanes. On aprons with tail-stand roads located on each side of a taxiway or taxilane, it is common for these tail-stand roads to be connected across the taxiway/taxilane by a service road marked on the pavement to provide vehicles a defined route to cross what can be expansive pavement areas.

Figure 9-18 Tail-Stand Road and Taxi-lane Configuration. (SOURCE: Google Earth Pro, CDM Smith Analysis.)



Roads Between Cargo Terminal Buildings – It is not uncommon for air cargo aprons to be supported by a vehicle pass-through road between air cargo terminal warehouses. These two-lane roads provide access to the landside parking areas through a secured gate. Vehicles which utilize these roads include trucks transporting bypass ULDs or loose freight as well as emergency and delivery vehicles. Figure 9-19 provides an example service road between two cargo buildings on the FedEx cargo ramp at Dulles International Airport.

Figure 9-19 Roads between Cargo Warehouses and Apron Configuration. (SOURCE: Google Earth Pro, CDM Smith Analysis.)

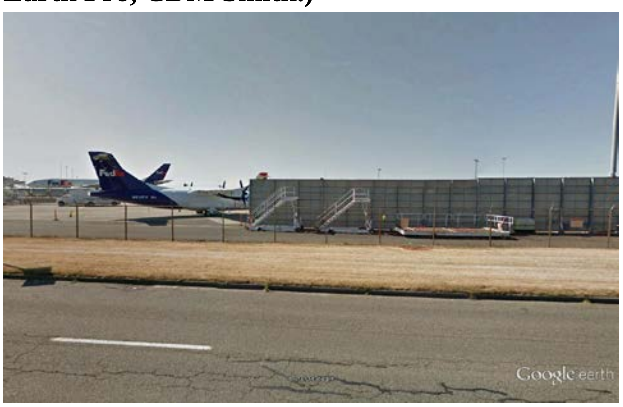


Push Back Area – When aircraft are parked perpendicular or diagonal to a cargo building a tug vehicle must push the aircraft back away from the structure to position the aircraft for access to the taxiway system. The push back process may move the aircraft into the aircraft movement area such as taxilanes and through the tail-stand roadway. (Movement areas under the control of the FAA ATCT controller whereas non-movement areas are not under ATCT control but aircraft may be under the control of ramp tower controllers when in non-movement areas). If there is ample space, it is ideal for airport planners to provide a pushback area to support aircraft departing from an apron, optimally without affecting airfield or apron area taxiing flows. The provision of an aircraft push back area can accommodate aircraft maneuvers, allowing aircraft to safely push back and start engines without adverse jet blast impacts or without penetrating the movement area (coordination with ATCT personnel would be required if penetration is unavoidable), or encroaching on any apron taxilanes used for the directional movement of aircraft. Figure 9-20 provides an example push back area between the hardstand and the taxi-lane.

Figure 9-20 Air Cargo Apron Push Back Area and Process. (SOURCE: Google Earth Pro, CDM Smith Analysis.)

Jet Blast Fence – Jet blast is the thrust-producing exhaust from a running jet engine and propeller wash pushed to the rear of the aircraft when in motion. Some air cargo aprons require jet blast fences to deflect jet blast, propeller wash, and noise when taxiing to and from the cargo apron.

Figure 9-21 Air Cargo Ramp Jet Blast Fence at SEATAC International Airport. (SOURCE: Google Earth Pro, CDM Smith.)



Cargo Apron Markings

FAA usually does not control aircraft activity on aprons and thereby does not publish guidance related to markings in the leased portions of the cargo apron. The Airports Council International (ACI), International Air Transport Association (IATA), ICAO, and Airlines for America (A4A) however, do publish passenger terminal and cargo apron marking guidelines. Airports and carriers need to coordinate the development of a consistent cargo apron marking protocol and have it applied to all appropriate aircraft aprons. This section is a generalized discussion related to common air cargo apron markings and guidelines available to the airport planner.

Lead-in/Lead-out Lines – Lead-in and lead-out lines are gate-specific pavement markings that allow an aircraft to taxi under its own power or to be towed into a gate or aircraft parking position. When an aircraft is parked appropriately the center of the aircraft fuselage will be centered above the marking on the pavement. These lines are typically yellow and the same width as the taxiway/taxilane centerlines, but in certain instances, a lead-in line is in black to provide contrast for light-colored pavement, such as concrete.

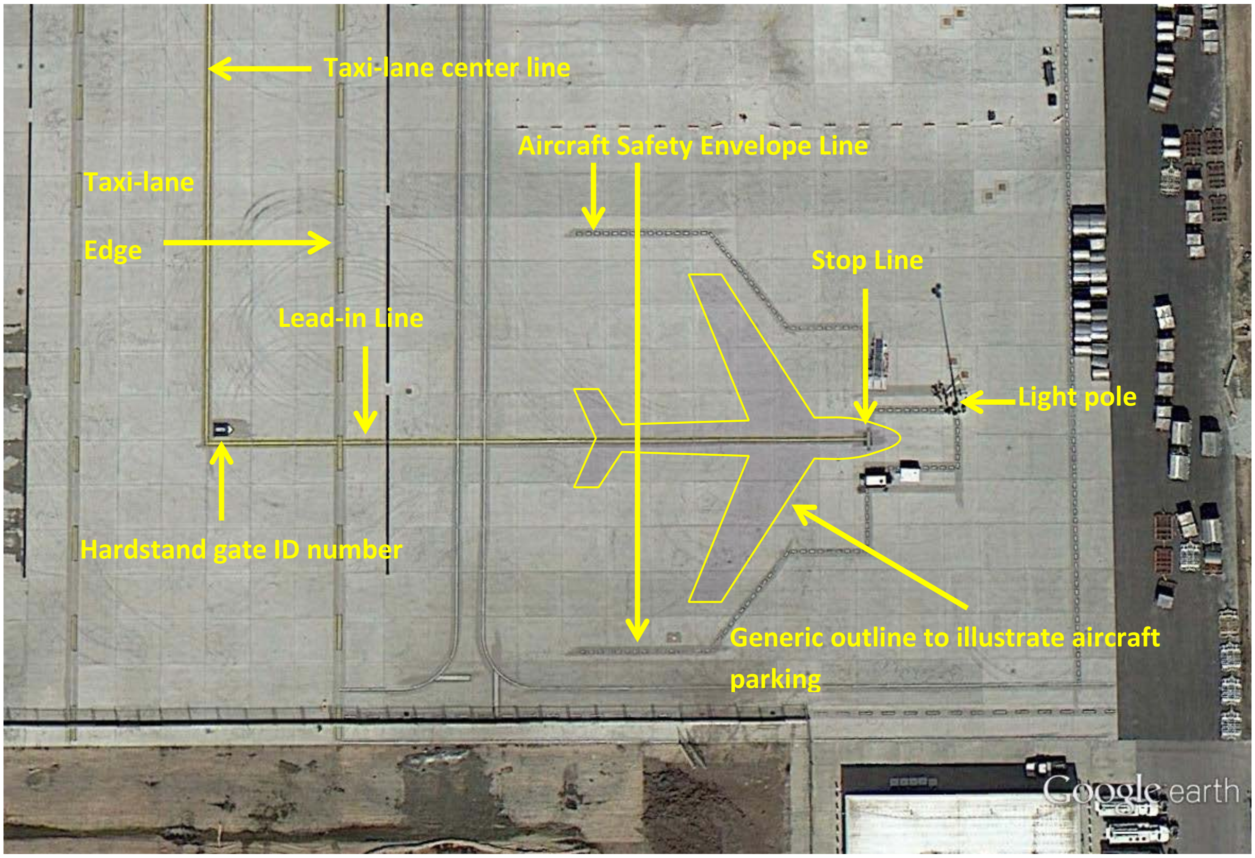
Stop Lines – Nosewheel stopping points along a parking centerline are typically labeled by aircraft type (B-757, B727, etc.) and are provided to aid aircraft marshallers and aircraft tug drivers in positioning aircraft.

Aircraft Safety Envelope – Aircraft safety envelopes define the areas where no vehicles or GSE should be positioned unless they are specifically servicing the aircraft occupying that particular gate. These lines, also called foul lines by ramp workers, provide necessary buffer from vehicles and equipment in the gate area that are servicing other aircraft on the ramp. The area outside of the aircraft parking and service envelopes up to the cargo building face, can be used for GSE parking, ULD storage and other apron activities. Many cargo operators use only white markings to identify the aircraft safety envelope. A4A recommends 10 feet as the minimum distance that the safety envelopes should protect from any point on the aircraft.

Ground Support Equipment

Ground Support Equipment (GSE) is the support equipment found at an airport, usually on the ramp, the servicing area by the terminal. This equipment is used to service the aircraft prior to and after air carrier flights. As its name implies, GSE is there to support the operations of aircraft and involves ground power operations, aircraft mobility, and loading operations (for both cargo and passengers). GSE used to service all cargo aircraft and the facilities that support all-cargo aircraft operations are substantially different from passenger terminal facilities and are usually best located in a designated cargo area. When ULDs are loaded into lower decks of aircraft air cargo GSE is likely located on the passenger terminal apron. GSE related to air cargo on the passenger ramp will include tugs, dollies and lower deck loaders.

Figure 9-22 Air Cargo Ramp Markings. (SOURCE: Google Earth Pro, CDM Smith Analysis.)



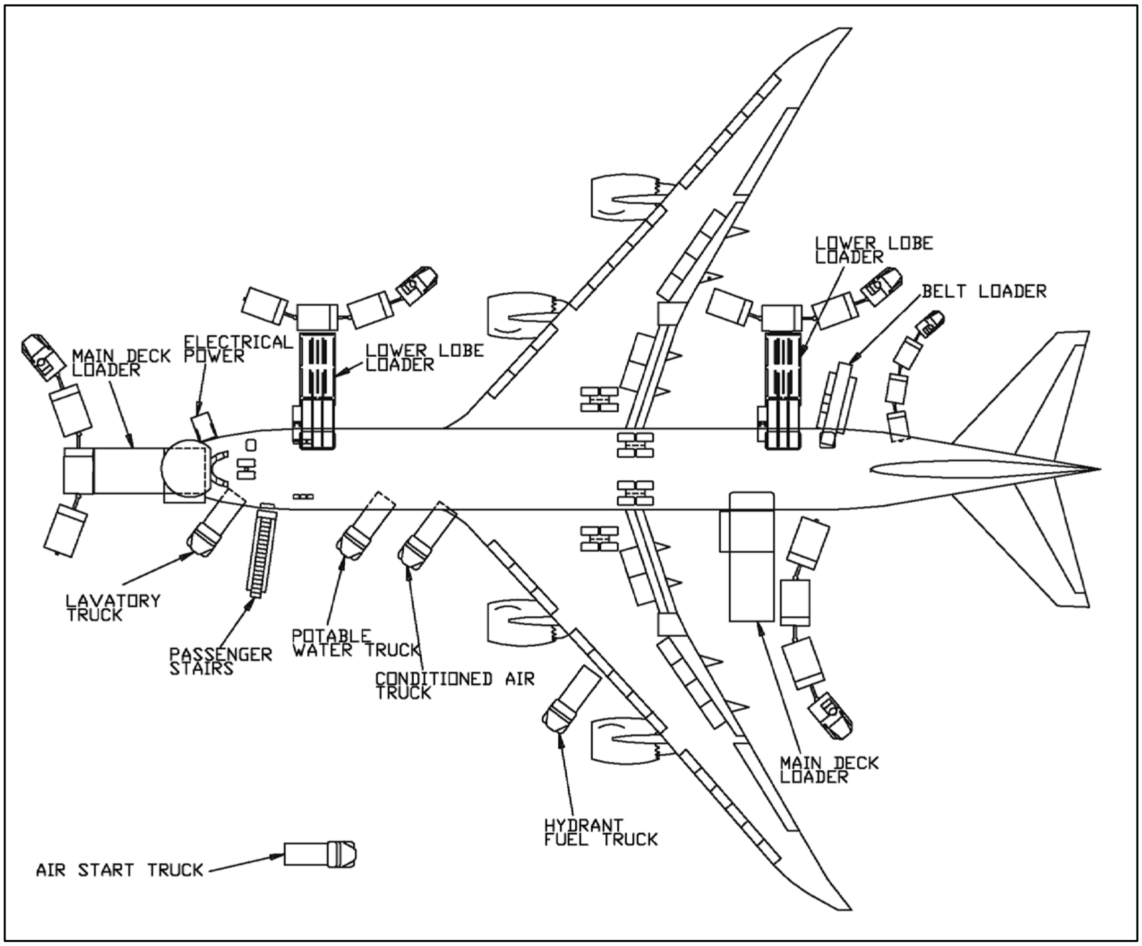
GSE Storage – GSE storage areas are used to park and stage GSE when not in use. These areas are often located on the apron in close proximity to aircraft parking positions, but outside the aircraft safety envelope. The position of aircraft parked on an apron typically provides large areas in front of its wings that are used for GSE storage and maneuvering. Prior to a flight's arrival GSE may be positioned by carrier personnel just outside the aircraft safety envelope to minimize aircraft access time. During periods on inclement weather and in latitudes where winters are severe cargo carriers may opt to store motorized GSE in a cargo terminal building or hangar. GSE with electric motors and are battery powered will need access to power plug-in outlets during storage.

Stationary GSE – When aprons consistently service on cargo aircraft type and park consistently at the same gate it often makes sense for the carrier or ground handler to install affixed GSE equipment. This would include mounted preconditioned air units, GPUs, lower deck loading units and potable water supply cabinets. Nose load docks may also be a fixed to the apron and lead out of the cargo terminal building. Some carriers also install covered side door loaders as denoted in Figure 9-14. The use of fixed equipment expedites ground handling and reduces congestion around the aircraft parking position by eliminating additional stand-alone carts or vehicles.

Mobile GSE – Most GSE is mobile and is transferred to and from the aircraft while it is being serviced. Equipment that is pulled up to the aircraft may include tugs, belt loaders, cargo (baggage) carts, empty dollies, loaded dollies (with ULDs and pallets), Loaders, fuel trucks, lavatory and potable water vehicles, stairs, main deck (nose door) loaders, and air start truck.

GSE Use – Generally speaking the larger the gauge of cargo aircraft being serviced the larger number of vehicles required to service it, which increases demand for GSE storage. Figure 9-23 identifies GSE in position to service a Boeing 747 with a cargo nose door.

Figure 9-23 Air Cargo GSE Service Areas for B747. (SOURCE: Boeing Aircraft Characteristics for Airport Planning.)



Security gates – Security of apron is largely controlled by ensuring that only authorized individuals or vehicles are provided access through security gates at the edges of the air operations area (AOA) or in cargo buildings. Cargo security gates are primarily used by airline support vehicles and entrance is gained by use of a magnetically coded card, lock and key, electronic device, or proximity badge. Access to service and cargo gates is restricted and typically requires cargo employees to complete specific training in order to obtain permission to utilize these gates.

Apron lighting – Artificial lighting on the cargo apron enables nighttime cargo operations at airports. By providing nighttime illumination of the apron air cargo aircraft handling, parking, and cargo sorting and processing is maximized. Safety and security are enhanced as well. There needs to be enough lighting on the apron to read labels, placards and documents as well as provide safety for ramp workers. Multiple zones of illumination can be achieved by the installation of both fixed and portable lighting equipment. Lighting is commonly affixed to the air cargo terminal building and where aprons are extensive in size light poles are utilized.

Deicing apron or pads – When aircraft are covered with frost, snow, and ice contamination on wings and other critical aeronautical surfaces prior to departure and deicing fluid is applied to remove the contamination and to prevent the accumulation of snow or slush for a period of time. If aprons are not equipped with the proper deicing fluid collection system, deicing fluid recovery vehicles or glycol recovery vehicles are used to recover deicing fluids on airport pavements. Deicing pads may also be located adjacent to cargo aprons to consolidate the deicing activity and collect fluids which are piped into storage tanks for recycling.

Hydrant fueling – Hydrant fueling systems consist of a network of underground pipes from airport fuel farm tanks to cargo hardstand locations. Fuel is pumped through the hydrant via a fuel cart to transfer fuel from the hydrant fueling network to an aircraft. Hydrant fuel "pits" are to be located near an aircraft fuel ports which is typically under the aircraft wing. The vehicles or carts are positioned by air carrier or contracted fuel staff near the underground hydrant pit and connected to the aircraft fuel tank port via a fuel hose and pressure coupling system. Once the hydrant fueling system is connected to the cart and grounded, fuel is transferred to the aircraft from the underground pipe system. When no hydrants are available fuel is transferred from a fuel truck to the aircraft via a fuel hose and pressure coupling system.

UTILIZING FACILITY PLANNING METRICS FOR CARGO WAREHOUSE DESIGN

As indicated in the cargo apron section, facility utilization data was based on analysis of 31 air cargo facility surveys for apron area, warehouse space, GSE storage and truck/auto parking. Airports were analyzed in this study to estimate the annual ton per square footage utilization of air cargo for warehouse. This section provides a facility requirements data matrix of ratios for the following cargo facilities based on cargo operator type, which include:

- Integrated express carriers
- Passenger airlines
- Third party providers/All cargo carriers

It is important to point out that these ratios are generic in nature to provide high level guidance for air cargo area facility planning and are not typically applicable to individual carrier practices which will likely have substantial variations in space requirements. These ratios, however, provide capacity requirements for air cargo activity on an airport. Carrier specific utilization data should be obtained during the inventory process.

Warehouse Throughput Analysis – Air cargo arrives via truck to the warehouse landside in one of two forms: as loose bulky cargo, including cargo bundled on wooden pallets; or as containerized, loaded ULDs and cookie sheet pallets. Warehouse throughput rates are the standard measures to define the capacity of freight facilities, and this rate is expressed in annual ton of freight per square foot of warehouse. Airport master plans can use several other methods for determining warehouse space. Air cargo throughput rates can include: number of ULDs arriving per year, annual bulk tons per year, annual tons per ULD storage position, storage positions per ETV, and annual tons per truck dock. For purposes of this framework the suggested throughput ratios are expressed in annual ton of freight per square foot of warehouse.

Integrated Express Warehouse – Integrated express carriers operate at most airports and have air cargo warehouses with truck dock doors and aircraft parking apron. However, one integrated express carrier commonly has a larger sortation facility on airport, and another maintains a much smaller warehouse and trucks air cargo off airport to a regional sortation facility. While this produces substantial variances in the amount of air cargo facility space required at an airport, both commonly have aircraft parking aprons at an airport if the airport does not provide a non-exclusive aircraft apron for loading and unloading of air cargo.

When planning for the amount of land required to accommodate a certain volume of air cargo at an airport, airport planners would be well advised to assume that both of the major integrated express carriers would eventually need air cargo facilities that include larger warehouse, aircraft parking aprons and truck circulation space and set aside ample land to accommodate a complete on-airport air cargo development.

Based on the survey data, air cargo warehouses for integrated express carriers at domestic airports average 29,100 ft^2 and at international gateway airports average 81,200 ft^2, and aircraft apron averaged 138,000 ft^2 at domestic airports and 305,000 ft^2 at international airports. GSE support space for integrated express carriers averaged 79,000 ft^2 at domestic airports and 171,000 ft^2 at international gateway airports.

This analysis provides airport planners ratios for determining space requirements metrics for the integrators. These suggested ratios are based on survey data from an extensive data collection effort. As presented in Table 9-12, warehouse space utilization based on annual cargo tonnage throughput arrives at approximately 0.92 annual tons per square foot for domestic cargo for integrated express carriers and 0.37 for the same carrier type at international gateway airports.

Ground Handling Companies/All Cargo Carriers – As presented in the previous sections, ground handling companies operate at both international gateway airports and domestic airports. Due to the similar operating nature of ground handling companies and all cargo carriers at airports, this analysis combines the requirements of each into one category.

Table 9-12 Air Cargo Facility Requirements Ratio Application: Warehouse.

	Annual Tonnage	Tons/Sq. Ft. Ratio	Warehouse Required in Square Feet
Integrated Express Carrier			
Domestic Warehouse	80000 /	0.92 =	86,957
Int'l Gateway Warehouse	80000 /	0.37 =	216,000
Passenger Airline			
Domestic Warehouse	80000 /	0.64 =	125,467
Int'l Gateway Warehouse	80000 /	0.64 =	125,467
Third Party Providers & All Cargo Carriers			
Domestic Warehouse	80000 /	0.81 =	98,400
Int'l Gateway Warehouse	80000 /	0.81 =	98,400

SOURCE: CDM Smith.

Applying the Air Cargo Warehouse Ratios

Similar to the apron ratios, the Air Cargo Facility Requirements Ratio Matrix provides the metrics for converting annual cargo tonnage flows into cargo warehouse requirements. Simplified calculations based on empirical data from this study's research assists in providing an order of magnitude of the air cargo warehouse requirements, in a preliminary design stage (Table 9-12). The size of the warehouse required (in square feet) for the typical cargo volume can be calculated by dividing the annual cargo volume by the appropriate ratio (in tons per square feet) found in Table 9-12. A representative value for an integrated express domestic O&D station warehouse is 0.92 U.S. tons/square feet per year. For example, if an airport had an integrated air express tenant moving 80,000 U.S. tons annually it would require approximately 87,000 ft^2 of floor space (80,000 tons divided by 0.92 square feet per ton). For the same amount of cargo volume at an integrated express international gateway, 216,000 ft^2 of warehouse space would be needed because it has a lower efficiency, as reflected in its smaller ratio. When applying the passenger airline ratio of 0.64 ton/square feet,[2] the amount of warehouse space required to handle 80,000 annual tons indicates a less efficient use of space for domestic cargo. Third Party Handlers and All Cargo Carriers would need nearly 100,000 ft^2 of space to accommodate the same amount of annual volume. This methodology can be applied to current conditions on the airport as well as forecasted air cargo tonnage.

CARGO WAREHOUSE DESIGN CONSIDERATIONS

When considering the entire universe of air cargo within the U.S. one finds the majority of tonnage concentrated at cargo hubs and gateway airports, rather than being equally spread across the entire U.S. airport network. In fact, analysis of ACI cargo tonnage data indicates that the total tonnage of the top 20 airports in cargo tonnage in the U.S. comprises 80% of all cargo enplaned and deplaned at the top 150 airports. The primary driver for these large volumes of cargo at these top 20 airports, are integrated express hubs, (at seven of the 20), and the global trade reflected in large volumes of imports and exports. These international gateway and hub airports then must be able to accommodate a large amount of cargo in a relatively short period of time. Cargo warehouses then are not really warehouses at all but are terminals, similar to passenger terminals, with capabilities to handle rapid change and flux, with dramatic variations in hourly demand. The cargo terminal serves four principal functions:

- conversion (break down and buildup of cargo pallets and ULDs),
- sorting, (arranging ULDs and cargoes by airline, destination, and flights),
- storage (on a short term basis), and
- facilitation (customs, etc.) and documentation.

Typical air cargo handling methods range from very manual and labor intensive to highly automated and depend largely on the volume and speed of cargo handling required at each airport. As previously mentioned, the air cargo marketplace offers a wide variety of systems ranging from fairly basic, to a dizzying array of technical sophistication. Each has their place, form, and function. As illustrated in Table 9-1, the type of handling system utilized is dependent to a large degree on the amount of cargo being handled and the speed at which it is being processed.

[2] Average tons/square feet ratio obtained from master plans analyzed in Literature Review task. Ratios from this study's survey effort resulted in ratios too low for facility forecasts.

Most landside air cargo terminal systems are simply dock doors to allow surface transportation (mostly trucks) to deliver the goods to the building. Not all surface cargo goes through buildings however. Many shipments are “built up” (prepared to be placed in the aircraft, either inside containers/ULDs or as break-bulk) and delivered through the airport’s airside security gates which allow trucking directly to the aircraft ramp, by passing the warehouse, where they are loaded onto the aircraft. But most shipments arrive through typical dock doors located along the landside of the cargo buildings. Again, some cargo has already been prepared off-site for shipment, while other cargo must be built up on site inside the cargo warehouse.

For purposes of this research airports in the U.S are broken down into two categories: Domestic O&D Airports and International Gateways. This analysis does not take into consideration the express carrier hubs. Integrated express hubs are highly specialized facilities designed to move large cargo volumes in a short span of time. Integrated express hubs are typically planned and developed by the carrier’s own industrial engineers or their hired engineering consultants. Hub development in the U.S. is considered fully developed and no new hubs are anticipated to be constructed in the next decade and will likely not happen within the next two decades. It is worthwhile to point out that there are several integrator hub facilities in the Ohio Valley that have been vacated and will likely never be utilized again as an air cargo hub. It is noteworthy to point out that the U.S. integrator hub and regional hub system is fully developed for the near to medium-term, at least. DHL lost in its bid to become a worthy third contender in the race and both FedEx and UPS have adequate spacing and capacity in their current networks.

International Gateways – The gateway functions as a consolidation, distribution, and processing point for international air cargo. These airports typically have substantial passenger airline activity with wide body aircraft capable of accommodating large volumes of air cargo in the belly hold compartments. Based on historic trends, gateway airports are best positioned airports to experience growth in international cargo traffic. To a certain extent, an international air cargo gateway is similar to a hub airport in that the gateway airport is not reliant on the surrounding market area to generate sufficient cargo to justify air cargo-related operations. As with the air cargo hub, much of the cargo moving through a gateway airport does not originate and is not destined for the gateway airport’s surrounding market area. Airports in the U.S. that are considered international gateway airports include: Miami, JFK in New York, Los Angeles, and Chicago. Evolving gateway airports include Atlanta, Dallas, and Houston. Detroit International Airport functions as a gateway to a lesser degree since the airport accommodates Delta international flights to Asia and Europe.

Domestic O&D/Local Market Stations – The criteria for a local market station, or direct air cargo service (origin and destination (O&D) service to an airport’s surrounding market area) generally coincides with population centers where there is a concentration of industry, commerce, and transportation infrastructure. Often referred to as a “node” within a cargo carrier’s network, the local market station is the simplest and most common type of air cargo facility. For airport-to-airport service providers, the local market station represents the origin or destination point for the cargo they are transporting.

The sole function of a direct air cargo service facility is to collect from customer’s outbound air cargo and distribute customer’s inbound air cargo to the airport’s surrounding market area. In order to make direct air cargo service economically feasible, the airport’s surrounding market area, or “catchment area," must generate enough inbound and outbound cargo and revenue to offset the carrier's aircraft operational costs. If the carrier cannot meet the aircraft operational costs, the cargo is trucked to the hub or another local market station where it is loaded onto an aircraft. Trucking to an airport outside of the market area is detrimental to the carrier's service delivery and pick-up times.

Air cargo terminals or warehouses are either occupied by a single tenant or by several tenants.

Single-tenant facility – This warehouse type is an air cargo building/warehouse with one occupant occupying the entire facility. At most airports, single-tenant warehouses are not the predominant facility. For domestic air cargo facilities single-tenant facilities are almost always occupied by an integrator. At international gateways single-tenant facilities are may be occupied by an all-cargo carrier, a third party handler, and an all-cargo carrier. There are also instances where the single tenant at gateway airports is a combi-carrier (passenger airline with a dedicated freighter fleet).

Multi-tenant facility – This warehouse type is an air cargo building/warehouse with several occupants occupying assigned areas in the cargo building. Tenants may be comprised solely of air cargo businesses and carriers or may be a mix of carriers and supporting businesses. Some may have no relationship with the air cargo industry but may only provide services to the passenger carriers.

Air cargo demand is generated when there is a need for expeditious transportation of material and goods between two points. In the business world, logistics managers must justify the use of air cargo as their preferred mode of transport, as shipping by air is a greater cost than shipping via truck, rail, and water. Factors involved in deciding to transport via air include:

- Cost of transporting the material
- Level of service commitment to the customer or end user
- Value of the material
- Time-sensitivity of the material

Products that benefit from increased speed of distribution or better stock availability provided by air cargo shipping include those that are high value, relatively light weight, and time critical, including:

- Aerospace – Equipment & Parts
- Automotive – Equipment & Parts
- Pharmaceuticals
- Pharmaceuticals – Active Product Ingredients
- Medical Diagnostic Equipment
- Medical Devices and Equipment
- Textiles – Garments, Apparel, Shoes, Textile parts
- Consumer Electronics
- Computers & Computer Components
- Telecommunications Equipment – Cell Phones, iPhones
- Software

- Perishables – Flowers, Fruit, Vegetables & Seafood
- Economically Perishable Materials – Printed Material

Perhaps one the most unique attributes of the air cargo industry is the rapid loading and unloading of commodities onto wide-body and narrow-body freighter aircraft via ULDs, including pallets and igloos. Cargo aircraft have large doors and rollers fastened to the deck of the aircraft. These aircraft allow containers and pallets laden with freight and mail to be rolled on and off aircraft whether manually or through a mechanized system.

Unit Load Device (ULD) – is either a container or pallet that is loaded onto the aircraft and unloaded at its destination. A container is an aluminum, plexiglass, fiberglass, box that is shaped to fit the contoured sides of an aircraft. A pallet is a solid wood, metal, or plastic transport structure on which shipments are stacked and wrapped in plastic and netting. The advantages of a pallet over a container are lower tare weight, cheaper to own/repair, easier to handle, and empty stacking. The main advantages of containers are that they are fully enclosed, protecting their contents from the elements and theft. A disadvantage of both is that they are easy to damage. ULDs loads can be assembled at the airport or arrive pre-assembled.

Widebody aircraft have rollers on both the main and lower decks while narrowbody aircraft have rollers strictly on the main deck. The lower decks of these aircraft are bulk loaded or load manually. Specialized ground handling equipment lifts containers and pallets to the main deck. Containers and pallets are typically loaded and unloaded in a warehouse which may or may not be located on an airport. Containerizing or palletizing air cargo allows for quick and efficient loading and unloading of aircraft as well as trucks. In addition, some warehouses have "roller deck" flooring which allows for movement of pallets and containers without the need for forklifts, dollies or tugs. Igloos are similar to ULDs but are designed and contoured to load into the main deck of a passenger airline equipped to accommodate both passengers and igloos.

Figure 9-24 Examples of Unit Load Devices.
SOURCE: i and ii CDM Smith, iii Rickenbacker International airport.

(i) Upper Deck Container

(ii) Lower Deck Container

(iii) Upper Deck Pallet

Approximately 50% of international air cargo travels in the baggage compartment, or lower deck, of passenger aircraft; this cargo is also referred to as "belly cargo." The wide-body aircraft that typically serve these routes offer substantial freight capacity in lower deck containers.

Narrow-body jet aircraft, such as freighter versions of the Boeing 757, Boeing 737 and DC9, are typically used for short haul domestic routes, while feeder aircraft serve small market needs. Narrow-body aircraft payloads range from 18,000 pounds to 95,000 pounds. Feeder aircraft payloads can range from 2,000 to 10,000 pounds. Upper decks on narrow-body aircraft accommodate containers, while the lower deck is bulk loaded in a process where individual pieces of freight are placed directly into the aircraft without the benefit of containers. Feeder aircraft are typically bulk loaded only.

CARGO STORAGE AND HANDLING SYSTEMS

Air cargo (mail and freight) typically arrives on the landside of an air cargo warehouse in two forms: containerized on air cargo pallets and ULD containers or in bulk form, which is comprised of loose parcels and packages which require sorting and batching prior to loading onto air cargo pallets or packed into ULDs. Additionally, some air cargo parcels, boxes and packages may arrive on wooden pallets which require fork lift transfers into ULDs or air cargo pallets. Cargo arriving on the landside is unloaded from trucks typically via a truck loading dock.

Typical storage methods include conventional pallet single-deep racks, double-deep racks (allowing for two pallets to be inserted into a slot), drive-through racks (can be entered from either end), cantilever racks, pallet staking frames, and gravity-flow racks. Similarly, typical equipment in an air cargo warehouse includes forklift vehicles, narrow-aisle trucks, transfer devices, elevating transfer devices, and storage-retrieval machines. The amount and type of equipment depend primarily on the type of carrier or operator utilizing the space. In a terminal dedicated to integrated express parcel processing, the operations (mainly sorting) may be performed at ground level as well as elevated conveyor and slides system. Arriving air cargo is handled in a number of methods depending on the level of warehouse automation but three categories of cargo warehouse emerge as the most common types:

Manual Load Facilities – These are often, but not necessarily, low-volume terminals. Where manpower is both available and inexpensive, freight may be moved by hand and fork lifts. Extensive layouts of roller beds and transfer tables may be utilized. Racks may be used to store lose cargo but not ULDs. Such terminals are also desirable when there are limited funds to purchase equipment and where the operator's staff lack skilled labor for equipment maintenance.

Figure 9-25 Examples of Manual Loan Facilities. (SOURCE: CDM Smith.)

Moderately Mechanized Sort and Load – ULD Containers are moved by extensive layouts of roller beds, mobile lifting and transfer equipment, for example, forklift trucks. Conveyor systems and sortation platforms and slides may comprise the integrated express terminal interiors. ULDs may be stored on racks. These open mechanized terminals are suitable for medium freight flows but incorporate two major disadvantages: they are space extensive and the forklift operations incur very high levels of ULD container damage.

Figure 9-26 Examples of Moderately Mechanized Sort and Load. (SOURCE: CDM Smith.)

Automated Terminals and Gateways – Involving Transfer Vehicles (TVs) and Elevated Transfer Vehicles (ETVs), these heavily automated facilities use single- or multiple-level storage of containers, which are moved within the terminal mainly by railed transfer vehicles. ETV operations produce high throughputs per square foot, with minimum container damage and reduced labor requirements. These facilities are very expensive to construct and operate and require a steady stream of demand for return on investment. The advantages of this system include the savings in the number of workers and floor area, the potential for the maximum utilization of cargo terminal space, the minimization of accidents, enhanced security of the air cargo, and the minimization of damage to cargo and ULDs.

Figure 9-27 Examples of Automated Terminals and Gateways. (SOURCE: Lynxs Group.)

CARGO WAREHOUSE BUILDING HEIGHT

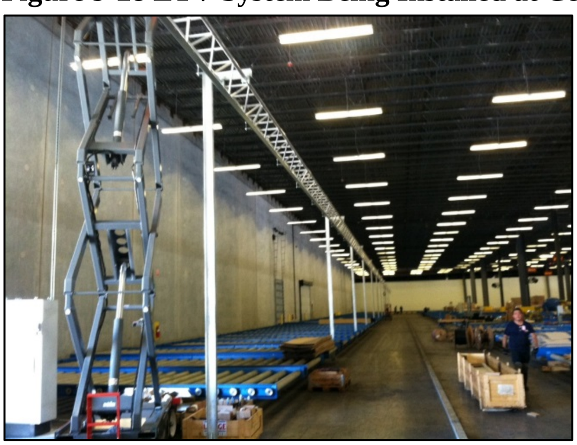
Air cargo warehouses in the past were often merely concrete pads with a roof and walls to function as cargo consolidation and sorting stations for passenger airlines. The early cargo warehouses were often refitted aircraft maintenance hangars located on a remote part of the airport. Transporting the cargo within the building from the storage area, to the processing area and truck doors was often inefficient and space intensive. Placing the cargo on racks improved the efficiency but tug times to the aircraft were not due to the remote location. First generation cargo exclusive buildings were low rise structures with lower productivity per square foot since racking cargo vertically was limited. These buildings were placed closer to the terminal but were limited in foot print and the number of truck doors was limited when compared to today's standards.

The international passenger gateway airports were often times land constrained and space for air cargo terminals came at a high cost. Airport planners and industrial engineers had no choice but to design and build taller air cargo warehouses in order to fit them on a limited land envelop. Today, at the largest international gateway airports air cargo facilities may have up to 40 foot ceiling heights with multiple levels of build and break space as well ULD and pallet storage. These facility's operators use IT systems to anticipate loads based on bookings, airlines schedules and truck delivery schedules. These modern facilities are designed for specific airlines or third party handlers with a particular profile in commodity types, operating equipment and schedules thereby increasing facility efficiency. If these facilities are vacated, however, it is often times difficult to find a replacement tenant which requires identical industrial designs. Retro fitting these facilities can come at great expensive to the facility owner.

The maximum storage height depends on the cargo handling and ETV equipment capabilities, the quality of floor leveling (which can impact racks and ETV installation), and the storage policy of the terminal (priority cargo is stored at low levels for faster access). In multi-rack storage systems, pallets are placed into fixed-dimension slots, and the typical height of a commodity pallet plus a height margin multiplied by the number of rack levels leads to the total height requirements in the warehouse area. When this height is already determined (e.g., in the reengineering of an existing air cargo facility), a similar calculation will provide the maximum number of levels in the multi-rack storage system. A typical height dimension for an Automated Terminals warehouse is 35 feet, but the planner should take into account the specifications for the minimum distance between the fire sprinklers systems, skylights, and roof trusses.

Airports that are land rich have the advantage of not necessarily building tall air cargo facilities since there is typically ample space for building horizontally. These facilities may require vertical space for storage racks but may only need ceiling heights of 20 to 25 feet. The manual load facilities and the moderately mechanized sort and load facilities typically can function in these lower ceiling facilities, while the Automated Terminals and Gateways typically require higher ceiling heights.

Figure 9-28 ETV System Being Installed at Centurion Air Cargo Facility. (SOURCE: CDM Smith.)



An additional advantage of warehouses with higher vertical capabilities is that office space can be accommodated on a mezzanine if the warehouse is equipped with one. Mezzanines provide cargo or equipment storage below and office space above. Airport planners need to be aware that ADA guidelines and requirements may apply to mezzanine installation.

TRUCK PARKING AND MANUEVERING SPACE CONSIDERATIONS

The landside element of an air cargo facility must have sufficient space for truck operations. While trucking companies make up the surface component of air cargo operations they rarely lease space on an airport yet airport planners must insure that air cargo warehouses where integrators, all cargo carriers and third party handlers lease space, be designed to accommodate trucking, including frontage, access and roadway geometry. In many airports, older cargo facilities were designed to accommodate smaller 40-foot long trucks but not today’s larger trucks (up to 75 feet) that are typically used for long haul trucking.

Another critical element of landside planning is the employee and customer automobile parking requirements for the air cargo facility. Ideally both must have close in parking that is physically separated from the trucking operations but often is not. In instances where automobile parking is limited, employee parking is usually shifted to a remote lot.

Most air freight facilities have to interact with trucks for pick-ups and deliveries. The place this occurs is the loading bay, which by definition is the area where goods are loaded on and off vehicles, and where the freight facility interacts with the outside world. Loading bays have the following physical features:

- At the truck-building interface are *loading docks.* Loading docks lead directly to *staging areas* inside the facility and, in taller warehouses, to ETV systems;
- Outside the warehouse building are *berths, parking pads, parking aprons*, *parking area*, and sometimes *gates*.

The loading dock is the crucial element that bridges the building and the truck. What should they look like and how should they function? According to the Whole Building Design Guide (WBDG), an information resource established by the National Institute of Building Sciences, loading docks should have the following design features:

- ***Location.*** Away from the main entrance and away from pedestrian traffic for safety reasons.
- ***Height.*** Typical loading docks are platforms built 55 inches high in order to accommodate most trucks. If the height of incoming vehicles’ truck beds vary by more than 18 inches at least one berth should have a dock leveler to adjust the height. Furthermore there should be a ramp of 1:12 grade from the loading dock to the parking area in order to facilitate unloading from the parking lot.
- ***Depth***. They should be deep enough for forklifts and other loading and unloading equipment, for rough sort, easy forward into the facility, and for distribution centers the modern standard is depths of 100 feet.
- ***Doors*** should be of the overhead coiling type and a small personnel door should be provided.

Within the facility, staging areas need to be big enough to keep the dock clear while goods are readied for movement deeper into the building. In multi-story structures, they should be adjacent to freight elevators, which themselves must be large enough to accommodate bulky items.

The property outside the building allows the truck to enter from the street, wait for entry to the loading dock, and maneuver in and out of the dock amidst other vehicles. For operations using drop trailers, there needs to be space sufficient to park a loaded trailer and to collect an empty trailer from an inventory in the yard. The outside components are berths, trucking parking, landing strips, aprons, and gates.

- *Berths* are where the truck pulls in. Loading docks typically are divided into individual dock doors, with the berth serving as the entry point. Given the width of tractor trailers at parking pads 102 inches (8'6"), the width of berths should be at least 12 ft. and are recommended at 18 ft.
- *Parking pads* are the concrete parking areas adjacent to the loading docks, sized to meet the largest trucks.
- *Parking aprons* are the maneuvering area for trucks to get in and out of berths and parking spaces.
- *Parking area* – The rule of thumb is that the number of truck parking spaces should be equal to the maximum number of trucks loading and unloading at any time (Tompkins and Smith, 1998). In the majority of situations where trucks are actively engaged in transferring freight, parking space is used for queuing and holding, and not for down time; in the absence of a loading dock, parking serves as a berth. Additional space is needed if trailers are being dropped, both to hold the loaded vehicle and to replace it from a supply of empties; aprons must accommodate this activity as well.
- *Gates* are security features typical of higher volume operations like large air cargo hubs and international gateways, or for valuable goods needing protection. Because trucks will queue as they enter and exit gates, approach areas or driveways should exist to allow it.

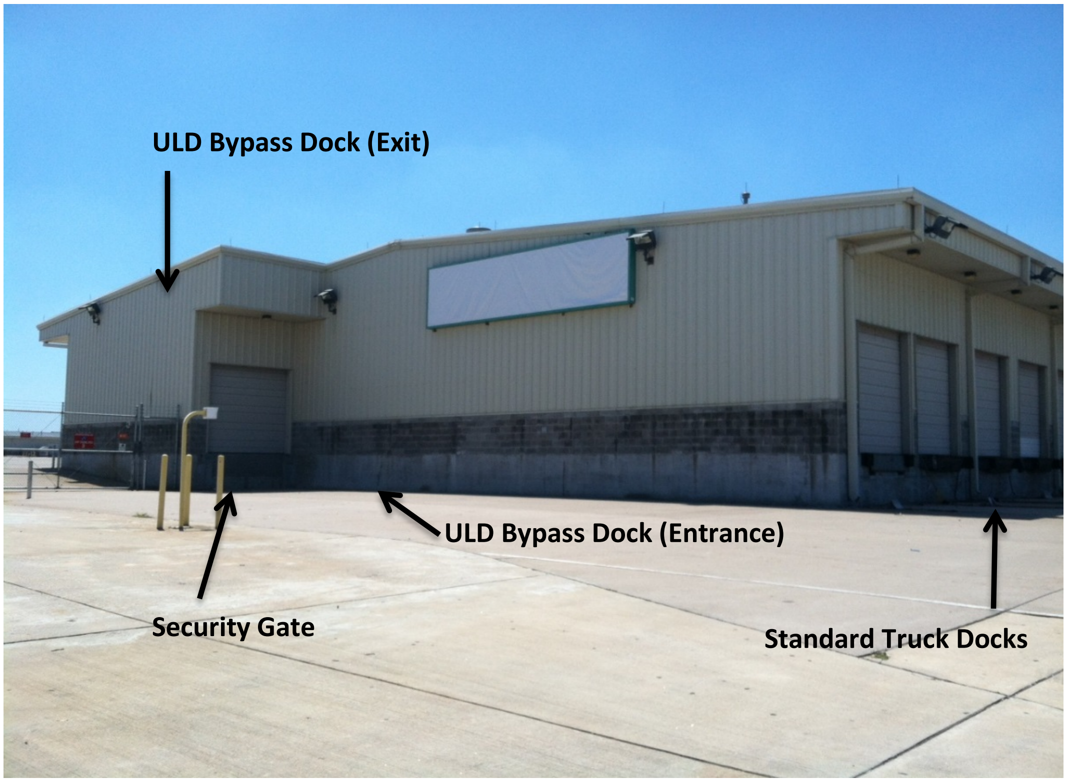
Truck Traffic

At the larger international gateway airports where the airlines and integrated express carriers have large air cargo facilities that drive a substantial amount of truck traffic, and even at domestic airports where the integrated express carriers have substantial truck traffic, air cargo facilities are best positioned in an area that has direct access to major vehicular roadways or freeways as well as the airside taxiway system. If at all possible, airports do not want air cargo trucks comingled with vehicles going to or coming from the airport passenger terminals. For example, at George Bush Intercontinental Airport, international freighter operations are located on the opposite side of the airport from passenger terminals and have direct access to the Houston freeway system.

Cross docking – In some cases air cargo may be cross docked to transfer inbound air cargo at "Airport A" to an outbound truck destined for "Airport B." For example, an airline in a large market with multiple airports to choose from may use one major gateway airport as a drop station for another major gateway airport. A reason for this practice could be that the airline does not have dedicated freighter/main deck service at one airport but does have it at another, or one airport has a strong market but that airline does not have the uplift capacity at that airport but has it at another airport. This cargo would not typically be reported to the airport by an airline as enplaned cargo and therefore, an airport will likely not know exactly how much cargo was being handled in that facility. These type of operations may be significant at some airports, and one study at JFK International Airport indicated anecdotal evidence placed these volumes at 25 % of cargo volumes may be cross dock related. This would significantly affect an airport's ability to plan future facilities and capacity as simply adding up tonnage from the airlines that use that facility may not be always lead to an accurate portrayal of actual usage. In fact, a facility may not appear to be operationally full, when reviewing the reported enplaned and deplaned volumes yet may be operating above throughput capacity without an airport being aware of the constraint.

Warehouse bypass – It is not uncommon for air cargo warehouses and aircraft parking aprons to be supported by a vehicle pass-through road between air cargo terminal warehouses. These two-lane roads provide access to the landside parking areas through a secured gate. Some airports do not allow trucks to pass through the security gates directly to the apron and so carriers have installed special docks for trucks to unload ULDs which bypass the main warehouse staging area. Figure 9-29 provides an example bypass dock at Austin Bergstrom International Airport.

Figure 9-29 ULD Bypass Dock at Austin Bergstrom International Airport. (SOURCE: CDM Smith.)



SUMMARY

The goal of Chapter 9 is to prepare a planning and development framework that is the basis for forming guidelines used by airport decision makers in planning and developing air cargo facilities. The framework builds on the airport master planning process with a focus specifically on the air cargo facilities and terminal areas. The framework is applicable to a range of airports and facility types based on the existing conditions analysis, environmental concerns, and industry trends. The chapter covered cargo facility layout strategies, a review of forecast techniques, cargo apron strategies, cargo building strategies and facility ratios. The framework is also the basis for the development of an Air Cargo Facilities Planning Model, presented in Chapter 12, which applies cargo facility requirement ratios identified in this chapter. The next chapter provides airport planners with the fundamentals of cargo facilities development strategies.

CHAPTER 10: STRATEGIC DEVELOPMENT PLAN IMPLEMENTATION

CHAPTER OVERVIEW

Airport planners continually face the challenge of designating land for air cargo facilities, planning for air cargo facilities at their airports, and whether to construct or renovate air cargo facilities when needed. The absence of reliable air cargo forecasts to assist airport planners in this process and the current uncertainty in the future of air cargo volumes does not absolve airport planners of ensuring air cargo facility capacity to meet the future demand; it just makes their job more difficult and forces them to rely more heavily on other indicators and methods for determining their airport's needs.

The intent of the section is to provide airport planners with a planning and development framework that can be used to guide airport decision makers in planning and developing air cargo facilities. This framework is intended to be applicable to a range of airports and facility types based on current conditions at airports, forecasted change, and the metrics set forth in Chapter 9 and to provide a guideline for development and implementation of a strategic development plan for airports to accommodate air cargo volumes in the future. The methodology of developing an air cargo strategic development plan is much the same as the process employed for air cargo in development of an airport Master Plan.

One overriding complexity in accomplishing this mission is the fact that there are significant differences in air cargo facilities between large hub international gateway airports and domestic airports, and those required by the airlines, integrated express carriers and third party ground handling companies. While large hub international gateway airports can have a significant portion of their air cargo flown in on international passenger and cargo airline flights, many domestic airports have the majority of their air cargo flown in and out of their airports by integrated express carriers whose facility needs are quite different. One common thread between the various sizes of airports, however, is that at most airports some air cargo volume is still transported on domestic airline aircraft and airports need to have appropriate air cargo facilities to accommodate them. The difference in the volume of air cargo handled between large international gateways and medium and smaller domestic airports produces a wide range of air cargo facility requirements at airports across the nation.

AIR CARGO STRATEGIC DEVELOPMENT PLANNING

An air cargo strategic development plan is a tool to accommodate the volume of air cargo and mail forecast for an airport. The critical elements of the plan include development of a realistic air cargo volume forecast and then determining how much land and air cargo facility capacity is required to accommodate forecasted air cargo. With air cargo volumes down by a substantial percentage since the beginning of 2000, some airports have surplus air cargo capacity that could accommodate future increases in air cargo volume, but may require relocation of users into larger surplus facilities or renovation of existing facilities. Other airports may need to create additional air cargo facility capacity through the designation of land and construction of air cargo facilities. Whatever the case may be, airport planners should, through the development of a strategic plan, determine what action is required to accommodate the forecast.

Determining Land and Facility Requirements

Once the air cargo forecast has been developed, the matrix tools presented in the previous section can be applied to determine if additional land needs to be designated on the airport for air cargo facilities or if air cargo facilities need to be constructed or expanded. In the short term, input from the airlines, integrated express carriers and ground handling companies is critical. In the longer term, where specific long term requirements of the airlines, integrated carriers and cargo handlers are not available, airport planners should rely on the air cargo forecast and the matrix data to plan for additional air cargo facilities and/or designation of additional land for air cargo facilities.

Depending on the volume of air cargo tons handled and whether the airport is an international gateway or a domestic airport, there are several different air cargo and associated support facility sizes required.

International Gateway Airports

International gateway airports are quite different from domestic airports. In addition to the integrated express carriers' air cargo facilities, these airports may have large U.S. based airline hubs and several international flag carriers that carry a substantial amount of air cargo in the belly of its passenger aircraft and/or operate cargo freighters. At these airports, it is common for the airlines and integrated carriers with larger operations to have their own dedicated air cargo facility that can be as large as 100,000 to 200,000 ft^2 with large aircraft parking aprons and as many as 50 truck dock doors. For those operating freighters, it is common to have large aircraft parking aprons capable of parking two to 10 B747Fs, along with space for B747-8s. This is according to the standards that the B747-8 is 18.4 feet longer and 11.4 feet wider than the B747-400 (Boeing, 2009)..Some airports have constructed large common use air cargo parking aprons for freighters where the load/unload functions are performed, rather than having exclusive use aircraft parking aprons located directly behind their air cargo facility. In this case, the air cargo is transported by tug from the aircraft to/from their respective air cargo facility which is ideally located within a reasonable proximity of the air cargo parking apron.

In addition, at many international gateways there are ground handling companies that provide cargo warehousing services for a single airline or multiple airlines in their own facility or a client's facility that need air cargo warehouse space, ramp space to store its ground service equipment, and facility space to maintain its ground service equipment.

Domestic Airports

At domestic airports, there are air cargo facilities that accommodate the needs of airlines' belly cargo, in addition to the integrated express carriers' facilities. Usually the airlines' air cargo warehousing areas are situated in multi-tenant facilities with truck dock doors on one side and access to the airport operations area on the other side. The air cargo facility usually divides the airport operations area from airport land outside of the airport operations area. Often, the airports build these facilities and lease a portion or bay to the airlines. The airlines in many cases construct administrative offices for its air cargo support staff within their air cargo facility and install secured areas for bonded shipments, high value shipments and aircraft parts storage. At smaller airports where the airlines handle around 1,000 tons per year, airports will have one airline air cargo building consisting of 50,000 ft^2 with eight to ten bays of about 6,500 ft^2, with two truck dock doors and access to the airport operations area.

In addition to the airline air cargo facility, many domestic airports have the vast majority of the air cargo handled by integrated express carriers. At smaller domestic airports the integrated carriers can handle as much as 50,000 tons of air cargo per year. The integrated express carriers either have a smaller sortation facility on-airport, transporting much of the air cargo off-airport to a larger regional sortation facility, or they have a larger facility on the airport for sortation. The integrated express carriers may require sufficient aircraft parking apron to park one or two B757F.

For example, if a warehouse needed is 50,000 ft^2 the truck parking space required is 90,000 ft^2 (50,000 x 1.8). Using the truck dock and door ratios for the same size facilities arrives at 33 doors and docks (50,000/1,500).

In planning for the airlines and integrated express carriers, the amount of space required to maintain the ground service equipment (GSE) also needs to be considered. If the ground service equipment cannot be maintained within their air cargo facility, then additional facility space is required elsewhere at the airport.

ALTERNATIVES FOR DEVELOPING AIR CARGO FACILITIES

When airport planners determine that additional air cargo capacity is needed, there are alternatives for additional capacity:

- Do nothing
- Redevelop existing facilities
- Develop new facilities
- Repurpose cargo facilities

Do Nothing Approach

First of all, airports could do nothing and force the airlines, integrated express carriers and third party air cargo ground handling companies to solve air cargo facility capacity issues themselves. In situations in which airlines choose not to disclose their air cargo forecasts, this might be appropriate. Once the airlines determine what they need, they will initiate discussion with the airport planners concerning where their facility should be located. However, the preferred alternative is for airport planners to be ahead of the planning cycle and in a position to guide development of these facilities to best serve the airport. Designation of land on an airport's Airport Layout Plan (ALP) for development of air cargo facilities is ideal with input from the airlines, integrated express carriers and ground handling companies included in the analysis before airport land is formally designated as such on an ALP.

Redevelop Existing Facilities

Whether or not the airport is experiencing overall growth in air cargo volume, some air cargo operators grow out of their existing facilities, leaving an opportunity for the airport to redevelop those facilities to meet another operator's need at the airport. For example, if an integrated express carrier decides to construct a new air cargo facility and vacate their existing facility, the airport has the opportunity to renovate or revamp the vacated facility to provide capacity for smaller airline air cargo operators, non-cargo users or ground handling companies. Assuming title to that facility has reverted to the airport, the airport could subdivide that former facility into several bays each with truck dock doors and access to the airport operations area. The airport could lease space in this converted facility to tenants and generate additional facility revenue for the airport. Another possibility is to lease that space to a ground handling company so that they could provide air cargo handling services to an airline or a third party, or for GSE maintenance and administration offices. Ground handling companies seldom want to construct new facilities at an airport and usually lease space in existing facilities that are somewhat older and more economical to lease.

Repurpose Facilities

In today's environment, airports may find that they have surplus air cargo space or even vacant air cargo facilities and the airport may be best off converting that space for another non-air cargo use or simply removing those facilities and making the land available for other uses at the airport. Example reuses that the research team observed during the data collection included space converted to airport maintenance equipment repair and storage, deicing support space, automobile rental support space, GSE maintenance and repair, and airline provision centers.

Develop New Facilities

If additional air cargo facilities need to be developed at an airport; there are four basic ways that new facilities can be developed:

- The airport develops the facilities internally.
- The airport outsources the development to a third party on leased airport land.
- The tenant develops its own new facilities on airport land.
- The airport and tenant develop a public/private partnership.

Airport Developed Facilities

Prior to an airport electing to develop an air cargo facility, securing necessary funding, and developing a pro forma projects a satisfactory return on invested capital, the airport needs to ensure that the tenants are committed to leasing space in the proposed air cargo facility. The best way to ensure that the prospective tenants will lease the facility upon completion is to have the prospective tenants execute a facility lease prior to breaking ground on the development.

When a new air cargo facility is needed at an airport, the airport can serve as the developer and manage the design and construction of the new cargo facility and upon completion the airport would be the landlord to the facility's tenants. Whether the air cargo facility is a smaller multi-tenant facility or a larger single user facility, the development of a pro forma business plan is necessary to forecast the lease revenue to be generated, the cost of operating the facility, the cost to construct the facility, the cost of funding, and the return on investment. When an airport is the developer, the airport is responsible for securing the development's funding as well as long term building maintenance, administration, and meeting tenant needs.

Funding can come from several sources. The airport can use available cash, but should be cognizant of the lost opportunity to fund other airport public infrastructure projects. Tax exempt bonds could be sold to fund the development. Private financing through a bank or financial institution is an alternative, but probably the most expensive alternative. AIP funding is another alternative through entitlements, PFCs or FAA grants. Entitlement funding for cargo projects is available if the airport handles over 100 million pounds of air cargo landed weight per year. Common use infrastructure that is not exclusively used by a single user may be eligible for grants either from the FAA or from local economic development agencies. Of all the alternative funding sources, grants represent the ideal source of funding. While there is a local matching payment required, the cost associated with using grant funding is more cost effective than the other alternatives. The most important objectives when an airport is deciding whether to develop an air cargo facility in-house and is reviewing funding alternatives are to maximize the airport's revenue and to ensure the on-going financial sustainability of the airport.

To design the air cargo facility, airports can either design it in house, if they have the expertise on staff, or engage a private sector architectural firm that specializes in the design of air cargo facilities or warehouse. Once the concept design has been completed, airport planners need to ensure that the development conforms to state and federal environmental regulations. If federal grant monies are utilized then an environmental assessment (EA) study will be required. Some airports complete this analysis as part of their Master Plan, but if not already completed and approved, then initially an environment assessment is required to determine the specific environment analysis that will be required. If the land where the airport wants to develop air cargo facilities impacts wetlands, for example, the environmental analysis will be more complex and may require an environmental impact statement (EIS). If the land does not have to be significantly altered, the study could be much easier and a lot less expensive. Even if initial designation of a site for an air cargo development is through the development of an airport Master Plan, eventually an environmental assessment and subsequent environment analysis will be required. The cost to complete the necessary environmental analysis usually ranges from $30,000 to $500,000 depending on the complexity of the land preparation envisaged. Environmental impact studies are usually outsourced to environmental firms that specialize in environmental analysis. Traffic and roadway studies may also be required particularly in the busy gateway airport areas such as San Francisco, New York and Miami.

In order to obtain AIP funds, the FAA requires an airport to have a 5-year Airport Capital Improvement Program (ACIP), which details and prioritizes the airport's capital improvement needs for AIP funding. In addition to an ACIP, the project must be on an approved ALP, and have environmental analysis in the form of an EA or an EIS. After environmental assessment study has been completed and has been adopted as compliant with federal NEPA rules, the airport's architect can commence with the detailed facility design, preparation of construction plans, and secure the necessary permits. Like most other airport projects, competitive bids are required. At the completion of the bidding process, a construction company is selected and the airport executes a contract with the construction company to build the facility. The selection normally requires the approval of the airport's governing body, and the construction company has to produce the required insurance certificates and completion bonds before ground can be broken. Upon completion of the construction of the facility, the agency responsible for permitting and code compliance issues a certificate of occupancy permitting the airport and its tenants to use the facility.

The benefit of an airport constructing the facility themselves is that the airport not only enjoys the ground lease revenue, but also the revenue from leasing the facility to a tenant. Again, airport planners need to ensure that there is a favorable return on its invested capital and review all the risks associated with this type of development. Risks include loss of tenants due to airline mergers, third party handler consolidations and airline bankruptcies to name a few.

Third Party Developers

When an airport needs an air cargo facility built for a tenant, or when a tenant wants an air cargo facility constructed but does not want to lease the airport land themselves, they will engage a third party developer to lease the required land, design the facility, develop the site, and construct the facility. Third party developers are interested in taking on projects of this nature provided that the tenant(s) is a reputable company and a good credit risk. The developer will usually lease the land from the airport for 20 years, secure the necessary funding, and manage the entire design, development and construction process. The developer will go through the same vetting process outlined in the previous example to ensure that the development is economically viable, complete the environmental analysis required, and secure the necessary permits to construct the facility. The difference is that the developer will ensure that the funding is in place, pay for the design, the environmental studies, permitting fees and construction, and once the facility has been constructed the developer will lease the facility to its tenants. There are several large air cargo development companies that specialize in this kind of entity.

The benefit of having a third party developer construct the facility is that the airport receives the ground lease revenue for the duration of the lease term, does not have to manage and fund the development, but upon termination of the ground lease, takes title to the facility. Most cargo facilities have a useful life beyond the average ground lease term. After the title has reverted to the airport, the airport can then lease the ground, the improved areas around the facility, and the facility for several more years creating an additional revenue stream for the airport without having to invest any capital. While airport ground lease for air cargo facilities range from 20 years to 60 years, the average ground lease term is in the 30 to 40 year range.

User/Tenant Developments

Some airlines, integrated express carriers, and ground handling companies prefer to simply lease land at an airport and construct an air cargo facility to their own specifications. At many international gateway airports where the airlines have larger air cargo facilities, the usual practice is for the user or tenant to lease the land and construct or have a third party construct the facility. Normally, users or tenants in this case will engage a third party developer to design and construct the facility. The funding for construction of the facility would be provided by the user or tenant.

Public/Private Partnership

One alternative to constructing an air cargo facility is to develop an arrangement with a third party developer or tenant/user that allows the development of an air cargo facility to be financed through governmental loans at rates much lower than through a bank or commercial lending institution. The lower financing costs can take a marginally profitable project and make it economically viable.

At Anchorage, the airport was able to secure state funding at very favorable rates that improved the pro forma for an air cargo development. The airport, however, had to take title to the facility and lease it back to the developer in order to qualify for the favorable state funding. While these public/private partnerships can be economically advantageous, they can be somewhat complex and require a fair amount of creativity.

Another example of a public/private partnership is a case where an airport was able to secure funding from a state economic development agency to construct a facility. A third party was engaged to construct the facility and upon completion the airport took title to the facility and leased the facility back to the ultimate user.

The benefit of public/private partnerships is that the grant funding or state financing reduces the cost which improves the overall economics of a development. In these cases, the airport benefits by leasing the ground and facility to the user and enhancing service at the airport. In this type of arrangement, the airport has the option of serving as the developer, engaging a third party developer to construct the facility, or having the tenant be the developer.

Development Pro Forma

When an airport is interested in constructing an air cargo terminal and being the developer, it is imperative that the airport planners develop a financial pro forma. A pro forma is a hypothetical statement showing income and expenses that may be recognized in the future from a business venture or a real estate development. For an airport air cargo development, it captures the various sources of income that can be derived from a development, the expense associated with operating the facility including debt service if applicable, and the construction soft and hard costs. When all of the revenue and costs have been determined, the airport planners can calculate the net present value of the development and the internal rate of return which illustrates the financial viability of the development and return on investment.

Table 10-1 below shows the Construction Cost Budget for the development of a 200,000 ft^2 air cargo facility on 15.57 acres with 162,165 ft^2 of warehouse space, 37, 835 ft^2 of office space, 217,800 ft^2 of aircraft parking apron, 174,240 ft^2 of truck access and vehicle parking using average construction costs. In the Comments column, a description of each line is included along with whether the cost item is applicable in this example.

Table 10-1 Airport Developed Cargo Facility, Construction Cost Budget.

Construction Cost Budget				
Infrastructure Costs	**Total Cost: $**	**Cost/SF**	**% of Total**	**Comments**
Site Acquisition	-	0.00	0.0%	Ground Lease - no acquisition cost
Fees & Allowances	300,000	1.50	1.4%	Infrastructure fees & permits
Title/Document Fees	15,000	0.08	0.1%	May not be required due airport land
Title Insurance	-	0.00	0.0%	Lenders may require anyway
Acquisition Expenses	60,000	0.30	0.3%	Contingency for unanticipated costs
Total Infrastructure Costs:	375,000	1.88	1.8%	
Financing Costs	**Total Cost: $**	**Cost/SF**	**% of Total**	**Comments**
Debt Fee	210,000	1.05	1.0%	Commission: third party placement of debt
Equity Arrangement Fee	-	0.00	0.0%	
Loan Closing Expenses	157,500	0.79	0.7%	Closing costs and legal fees
Appraisals	25,000	0.13	0.1%	May be required by lender
Independent Inspector	25,000	0.13	0.1%	May be required by lender
Construction Period Interest	735,000	3.68	3.5%	Interest on debt during construction
Total Finance Costs:	1,152,500	5.76	5.5%	
Soft Costs	**Total Cost: $**	**Cost $/SF**	**% of Total**	**Comments**
Feasibility Study & Due Diligence	75,000	0.38	0.4%	May be required by lender
Surveys & Soils Studies	50,000	0.25	0.2%	Required for design
Environmental Studies	25,000	0.15	0.1%	Required for jurisdictional compliance
Mechanical & Electrical	240,000	1.20	1.1%	Specialized engineering
Architecture	500,000	2.50	2.4%	Building design and working drawings
Civil/Structural Engineering	240,000	1.20	1.1%	Required for design
Site Security & Perimeter Fencing	75,000	0.38	0.4%	Construction site requirements
Professional Accounting	15,000	0.08	0.1%	May be required
Taxes & Insurance	180,000	0.90	0.9%	Construction insurance required
Legal Fees	150,000	0.75	0.7%	Ground lease & professional services
Administration & Management	50,000	0.25	0.2%	Developer overhead
Travel & Lodging	25,000	0.13	0.1%	Developer overhead
Development Fee	860,000	4.30	4.1%	Developer fee and profit
Project Management	210,000	1.05	1.0%	Third party project management
Leasing Commissions	-	0.00	0.0%	Third party lease sales commission
Soft Cost Contingency	315,000	1.58	1.5%	Unforeseen cost contingency
Total Soft Costs:	**3,10,00**	**15.05**	**14.3%**	
Hard Costs	**Total Cost: $**	**Cost $/SF**	**% of Total**	**Comments**
Warehouse & Office	15,333,176	76.67	72.9%	Construction of shell structure
Tenant Improvements	-	-	0.0%	Finishing specified by tenant
Specialized Tenant Improvements	-	-	0.0%	Special finishing required by tenant
Utilities Hook Up	75,000	0.38	0.4%	Utilities connection from perimeter of site
Signage & Graphics	35,000	0.18	0.2%	Tenant required and directional signage
Hard Costs Contingency	1,050,000	5.25	5.0%	Percentage of total development cost
Total Hard Costs:	**16,493,176**	**82.47**	**78.4%**	
Total Development Budget	**21,030,676**	**105.15**	**100.0%**	

SOURCE: Lynxs Group, RMJ Associates

Table 10-2 below shows the basic components of a Development Financial Pro forma for an airport air cargo development assuming that the land/facility are leased to the tenant on a triple net basis (NNN) with the tenant paying facility rent, facility operating expenses, taxes, maintenance, and insurance:

Table 10-2 Income Pro Forma.

Revenue	
Ground Lease:	The revenue that an airport would receive from a tenant for leasing the parcel of land on which an air cargo facility development would be built. Any increase in the ground rent due to CPI increases or ground rent appraisals should be included.
Improved Ground Lease:	The revenue that an airport would receive from a tenant for leasing areas that have been improved such as the aircraft parking apron, truck dock access area, or parking lot area. Any increase in the improved ground rent due to CPI increases or ground rent appraisals should be included.
Facility Lease:	The revenue that an airport would receive from a tenant for leasing the facility that the tenant would be occupying. This could be subdivided into warehouse space versus office space. Any increase in the facility rent due to CPI increases or facility rent appraisals should be included.
Vacancy Factor:	If any turnover is anticipated during the planning horizon, then the lost revenue due to a turnover vacancy should be included.
Expense	
Maintenance:	The cost that the landlord/airport would incur annually to maintain the facility or the major components of the facility.
Salaries:	The cost of the human resource required to oversee, manage, and account for an air cargo facility. This may consist of a portion of staff time required, but in any case their fully allocated overhead burden should be included.
Debt Service	The cost the airport would incur to pay off the principle and interest on capital borrowed to finance the development. Usually, there is an initial construction loan that is replaced with long term financing. The principle and interest for the long term financing would be included here.
Income	**The revenue less the expense.**
Capital Investment	The cost to construct the facility which is shown of the same line as the Income as a negative number.
Net Present Value	All costs and revenues in future years are discounted back to the base year. When the sum of the discounted revenues is greater than the sum of the discounted costs, the net present value (NPV) is positive and the investment is deemed to be financially viable.
Internal Rate of Return	The discount rate that makes the net present value of all cash flows from a particular development equal to zero. Generally speaking, the higher a project's internal rate of return, the more desirable the project. Many organizations have an established hurdle rate or investment criteria. If the IRR is greater than the hurdle rate the investment in the development is acceptable.

SOURCE: Lynxs Group, RMJ Associates

For this development, a hypothetical Development Financial Pro forma has been included to illustrate the financial plan for this development based on the following assumed airport lease rates:

Table 10-3 Development Financial Pro Forma.

Lease Area	Rate PSFPYR	Area: SF
Ground	$2.40	478,126
Improved Ramp	$0.24	217,800
Warehouse	$10.00	162,165
Office	$15.00	37,835
Paved Parking Lot	$0.12	174,240

SOURCE: Lynxs Group, RMJ Associates

Some airports lease the ground, warehouse, offices, apron area and parking area for one all-inclusive lease rate. In this example, the airport leases the ground at one rate, but then seeks to recover the cost to construct the apron and the parking lot by adding a premium over and above the ground rate for the improved areas. The airport also charges a different rate for the warehouse space and the office space in recognition that the office space including tenant improvements was more expensive to construct. It is assumed that the tenant will be leasing the entire development for at least twenty years, so a vacancy factor has been included in the Pro forma.

The financial analysis assumes that the airport secured a twenty year loan to finance the entire development and amortized the capital investment over a twenty year period. Only the first five years of the Development Financial Pro forma is shown below for illustrative purposes:

Table 10-4 Detailed Development Financial Pro Forma.

		Year				
Revenue: $	Capital	1	2	3	4	5
Ground Lease		1,147,502	1,170,452	1,193,861	1,217,739	1,242,094
Improved Ramp Lease		52,272	53,317	54,384	55,471	56,581
Warehouse Lease		1,621,650	1,654,083	1,687,165	1,720,908	1,755,326
Office Lease		567,525	578,876	590,453	602,262	614,307
Parking Lot Lease		20,909	21,327	21,754	22,189	22,632
	Total Revenue	$3,409,858	$3,478,055	$3,547,616	$3,618,569	$3,690,940
Expense: $		1	2	3	4	5
Maintenance		50,000	51,000	52,020	53,060	54,122
Management & Accounting		50,000	51,000	52,020	53,060	54,122
Principle & Interest		1,375,839	1,375,839	1,375,839	1,375,839	1,375,839
Other		25,000	25,500	26,010	26,530	27,061
	Total Expense	1,500,839	1,503,339	1,505,889	1,508,490	1,511,143
Operating Income: $	($21,030,676)	$1,909,019	$1,974,717	$2,041,728	$2,110,079	$2,179,797
NPV	**820,559**					
IRR	**10%**					

SOURCE: Lynxs Group, RMJ Associates

In this example, the Net Present Value (NPV) using a 9% discount factor is $820,559 which indicates the sum of the discounted revenues are greater than the sum of the discounted costs and the investment is deemed to be financially viable. The Internal Rate of Return IRR) for this example is 10% which represents a reasonable return on investment.

SUMMARY

This chapter provides airport planners with the fundamentals of cargo facilities development strategies. These strategies are intended to be applicable to a range of airports and facility types based on current conditions at airports, forecasted change, metrics set forth in the report, and to provide a guideline for development and implementation of a strategic development plan for airports to accommodate air cargo volumes in the future. The next chapter outlines the process used by the team to validate the Air Cargo Facilities Planning Model.

CHAPTER 11: TASK 9—VALIDATION PROCESS FOR AIR CARGO FACILITIES PLANNING MODEL AND INSTRUCTIONS

CHAPTER OVERVIEW

The model validation process was a two prong approach. The first was to provide airport planners for case study airports the opportunity to review the facility planning model and model instructions. In the second, the research team provided a similar opportunity for planners at airports unfamiliar with the study and subject matter to review the model and instructions in order to provide additional perspective. These review processes will assist in industry acceptance of the cargo facilities planning model and instructions. This process allows for additional feedback during the development of the final deliverables to ensure a comprehensive product is prepared to meet the needs of the intended audiences.

The research team received responses from 10 airports regarding the Cargo Facilities Planning Model. In all approximately 20 airport planners, real estate managers, and or directors reviewed the model to varying degrees of participation and thoroughness. Overall respondents are very complimentary of the model and two respondents put it to use on existing cargo projects. Table 11-1 below identifies participants in the model and instructions validation and the responses to the data collection. Relevant comments related to the model and instructions were incorporated into the final draft of the model which is included in these report appendices. Below are general comments regarding the model provided by participants:

- *"Overall this process is helpful in evaluating current use vs need as well as forecasting model for future use".*
- *"This was a helpful tool and exercise".*
- *"We used to validate the planning for a new airside freighter facility. It both validated that we were right on track with many/most aspects, but also pointed out that we were proposing too many aircraft parking spaces for the proposed size of the building, thus allowing us to adjust to both maximize the site and save money related to concrete (ramp) Very happy to evaluate. Hopefully a win-win".*
- *"Model is a good start to help planners focus on cargo facilities. Ratios are helpful planning exercise because they provide averages used across large survey of facilities. Might be helpful to provide ratios for large, medium and small hub airports. This way planners can apply "apples-to-apples" comparisons".*
- *"I noticed cargo inventory buildings used by transport companies, freight forwarders, brokers not included in the study (model) I also realized many airports have kicked them off the airport. But may be useful to airports pursuing non aeronautical development. Very good tool".*
- *"After reviewing the Model and its results with airport management, airport management agreed with its conclusions and felt the Model was very timely as they had already engaged a consultant to determine how much more auto and truck parking space they need to pave. They asked if they could share this Model with their consultant to challenge the consultant's findings".*

Air Cargo Facility Model: Survey Response

Survey participants were asked to complete a survey which provides inputs to measure the clarity of the instructions and ease of use of the air cargo facilities planning model. The survey also allowed for respondents to provide inputs into the usefulness of the model relative to their airport's cargo facilities planning needs. A copy of the survey is provided in Appendix A. Although the sample size is small general conclusions can be drawn from the responses and from respondent comments. Also, inputs were provided in follow-up face-to-face and teleconference meetings with several of the respondents.

Table 11-1 Air Cargo Facility Model Survey Summary.

Airport	Contact	Title	Number of Staff Reviewing	Finished Review	Survey Returned	Phone or Face-to-Face Interview	Notes:
LAN	Gary Bartek	Director Logistics	1	Yes	Yes	Yes	Provided positive feedback
LCK	Bryan Schreiber	Manager of Business Development	2	Yes	Yes	Yes	CRAA utilized model to determine real world air cargo project under consideration at airport. Found it very useful.
SAT	Joyce Wiatrek	Properties and Business Development Coordinator	1	Yes	No	No	
AUS	Medici, Joseph	Director Planning	1	Yes	Yes	Yes	
ANC	Teri Lindseth	Planner Manager	5	Yes	No	Yes	Very little O&D Traffic in ANC. They had trouble getting local cargo splits by carrier.
MCI	Mark VanLoh	Director	2	Yes	Yes	Yes	
DFW	Mark Witte	Manager, Industrial Development & Leasing	3	Yes	Yes	Yes	Very complimentary of model. Would like to have very specific inputs into the model.
IAH	Louis Aviles	Sr Exec Air Svc Development	2	Yes	Yes	Yes	Provided positive feedback
GEG	Larry Krautter	Director	2	Yes	No	Yes	Asked MP consultant to utilize model for master plan.
GTF	John Faulkner	Director	1	No	No	No	Didn't have time to respond but was interested

SOURCE: CDM Smith

Table 11-2 Air Cargo Facility Model Survey Response Summary.

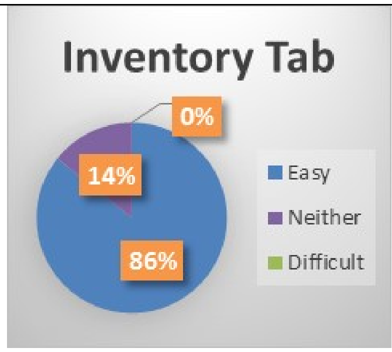
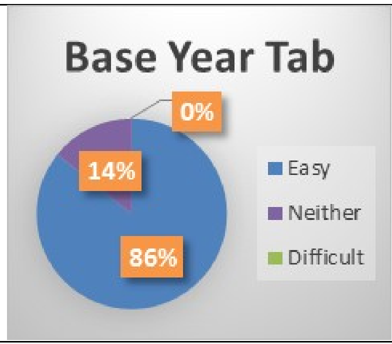
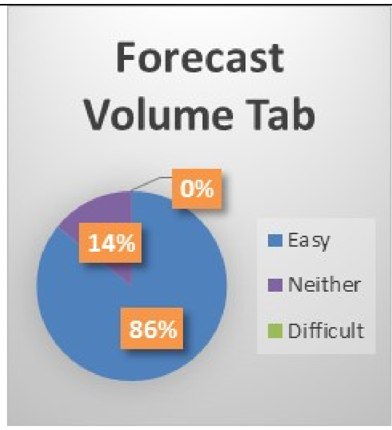
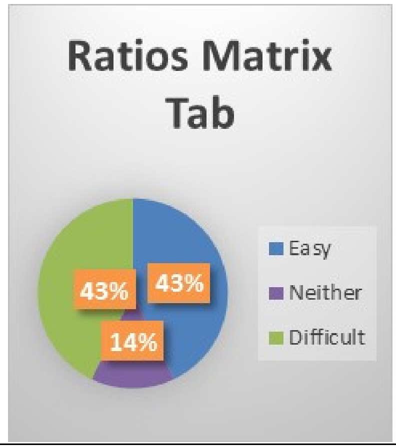
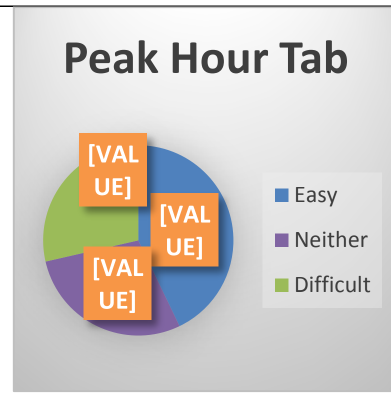
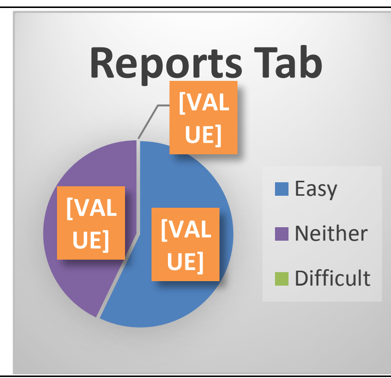
1. Inventory Tab Summary	**Results**
Question 1 allows for users to evaluate the ease of use of the model's cargo facility inventory input. The majority of users found the input easy to understand and make the inputs. Comments focused on: 1) needing clarification for subtenant inputs, 2) adding a note on the definition of cargo tenant types, and 3) providing "third party handler" as an additional tenant type. *CDM Smith response*: We added instructions in the Tenant Names column to add subtenants names along with primary tenants name, we also added example of tenant types to the instructions. Third party handler was added to the model as a choice of cargo tenant.	
3. Base Year Tab	**Results**
Question 3 allows for users to evaluate the ease of use of the model's cargo volume - base year tab. The majority of users found the input easy to understand and make the inputs into the model. Comments focused on: 1) highlight that inputs are to be in US Short Tons, 2) inputting the tonnage instead of having the market share % calculate the tonnage. *CDM Smith response*: We added instructions on the importance in using short ton for the inputs, but chose not to change the market share tonnage calculation.	
5. Forecast Volume Tab	**Results**
Question 5 allows for users to evaluate the ease of use of the model's cargo volume forecast tab. The majority of users found the input easy to understand and make the inputs into the model. Comments focused on: 1) most respondents did not have a current cargo forecast to refer to. One made a suggestion to "list FAA Boeing Airbus forecasted growth rates to assist use since too many airport master plans are out of date". *CDM Smith response*: While the Annual FAA Aerospace Forecast and Biannual Boeing cargo forecast are often used by airport planners to determine growth rates for air cargo, we recommend airports determine their own air cargo growth rates using a number of sources and methods either through the master planning update process or internal analysis.	

Table 11-2 (*continued*) Air Cargo Facility Model Survey Response Summary

<table>
<tr><th>7. Ratios Matrix Tab</th><th>Results</th></tr>
<tr><td>Question 7 allows for users to evaluate the ease of use of the model's Ratios Matrix tab. While the majority of users found the input easy or neither easy nor difficult 43% found it difficult to understand and make the inputs into the model. Comments focused on: 1) Some respondents were not sure what this tab is providing and the downstream implications in the model (how it affects facility requirements tab), 2) one respondent thought the ratio tab was hard to understand because of our unfamiliarity with the "proper" cargo planning ratios. This airport stated they simply provide space and the tenants typically accommodate their space needs accordingly. CDM Smith response: Instructions expanded on how the ratios are used in the model and derive the spatial requirements. In our research we did find that some airports have a "take-it-or-leave-it" approach to carriers needing cargo space. This response confirms the practice.</td><td>
</td></tr>
<tr><th>11. Peak Hour Tab</th><th>Results</th></tr>
<tr><td>Question 11 allows for users to evaluate the ease of use of the model's Peak Hour Aircraft Parking tab. While the majority of users found the input easy or neither easy nor difficult 30% found it difficult to understand and make the inputs into the model. Only one comment was made pointing out the need for an explanation of "worst case aircraft parking scenario" inputs day/time with more aircraft on the ramp. Another comment thought that the Antonov 225 aircraft should be added to the aircraft ARC reference guide. CDM Smith response: We noted in the instructions that the model allows for as many aircraft that a planner wishes to input – to model worst case scenario for peak hour or <u>event</u> demand, such as aircraft "remain overnight" analysis. We added the AN-225 to the reference sheet and increased the s.f. requirement for all D-VI aircraft to 125,000.</td><td>
</td></tr>
<tr><th>13. Reports Tab</th><th>Results</th></tr>
<tr><td>Question 13 allows for users to evaluate the ease of use of the model's cargo facility reports. The majority of users found the input easy to understand. Comments focused on: 1) adding some space so the table is less crowded. CDM Smith response: We reformatted the report layout a bit.</td><td>
</td></tr>
</table>

SOURCE: CDM Smith

Air Cargo Facility Planning Model Survey Implementation

The following chapter provides instructions for Air Cargo Facility Model users. Comments provided in the surveys for this validation process were taken into consideration and many were implemented in these instructions as well as in the preparation of the final model.

SUMMARY

The study team developed an Air Cargo Facilities Planning Model to guide airport planners in the process of determining current and future cargo facility requirements. During the development of the model it was tested by professional airport planners at select U.S. Airports. Airport planners at case study airports were given the opportunity to review the facility planning model and model instructions while a similar opportunity was given to planners at airports unfamiliar with the study and subject matter. Participants were asked to complete a survey to provide inputs on instruction clarity as well as ease of use of the model and its usefulness. Overall respondents are very complimentary of the model and two respondents put it to use on existing cargo projects. Relevant comments related to the model and instructions were incorporated into the final draft of the model. The following and final chapter provides the instructions on how to utilize the Air Cargo Facilities Planning Model.

CHAPTER 12: AIR CARGO FACILITIES PLANNING MODEL INSTRUCTIONS

CHAPTER OVERVIEW

As part of Airports Cooperative Research Program Project 03-24 the team was tasked to develop Air Cargo Facility Planning and Development Guidelines. A key component of these guidelines is an Air Cargo Facility Planning Model which provides airport planners a single source for calculating space and facility utilization for future air cargo buildings, apron area, and parking space. As part of this ACRP study, and as described in the previous chapter professional airport planners tested this model for the project's validation process.

This model is designed to be used to estimate space utilization for air cargo facilities on airports. The model is flexible in that it can estimate spatial utilization for all cargo areas on an airport as well as specific facilities on an airport. It is designed with two types of airports in mind: airports serving primarily domestic air cargo demand and airports serving international air cargo demand. The latter are considered "international gateway" airports. The purposes of this model include:

- Modeling all air cargo facilities (buildings, apron areas, and vehicle parking) on an airport.
- Modeling a single air cargo facility (building, apron, and vehicle parking) on an airport.
- Modeling an integrated express air cargo hub.
- Determining whether all air cargo facilities currently offer adequate space.
- Determining whether an air cargo facility currently offers adequate space.

Getting Started

Since the model follows the basic structure of an airport master plan several preliminary steps are required for testing the model. Be advised that if data inputs are not readily available significant research may be needed to collect the data prior to entering it into the model. Items needed for air cargo facility analysis include:

- List of all cargo buildings, vehicle parking and apron area dedicated to air cargo activity.
- List of all cargo related tenants on the airport and their location.
- List of unoccupied space in air cargo buildings, vehicle parking, and apron area.
- A copy of the airport's most recent master plan.
- A copy of the airport's most recent airport layout plan (ALP).
- Access to Google Earth or Google Earth Pro or other aerial photography of the airport environs.
- A scale ruler and aerial photo may be needed to determine space in air cargo buildings, vehicle parking, and apron area if an inventory of these facilities does not exist. Google Earth Pro provides area calculation function.
- A forecast of air cargo tonnage. This may be found in the most recent master plan or developed by airport planning staff or the airport's planning consultant.
- Current air cargo tonnage by carrier. This data will be used to determine cargo volume market share by carrier type.

COLLECT AIR CARGO FACILITY DATA

The airport master planning process includes completing an inventory of all facilities on an airport, including air cargo facilities. This model requires air cargo facility data to be separated into the five categories which are provided in the model. Once data has been collected, it can be entered into the inventory sheet in the model. Airport planners can utilize Airport Layout Plans ALPS and as-built schematics, as well as aerial photos, to determine the dimensions and area of cargo buildings, ramp area for aircraft parking, and space dedicated to ground service equipment storage and vehicle parking area. For this model, area values should be entered in terms of square feet.

Step 1: Enter Air Cargo Facility Data

Open the MS Excel – Air Cargo Facilities Planning Model file. A worksheet titled Cargo Facility Inventory allows for cargo facility metrics to be entered into the model.

Figure 12-1 Air Cargo Facility Inventory Data. (SOURCE: CDM Smith.)

Cargo Building Name	Usage	Tenant Names	Tenant Type	Warehouse Space (sf)	Dedicated Ramp/Aircraft Hardstand Area	Dedicated Ground Service Equipment [GSE] Storage (sf)	Total Apron (sf)	Landside Truck and Auto Parking (sf)	Number of Landside Truck Docks/Doors	Number of Airside Truck Docks/Doors
Building A	Cargo Related	ABC Express	Integrated Express	50,000	100,000	80,000	180,000	22,000	7	2
Building B	Cargo Related	XYZ Airlines	Passenger Airline Belly Cargo	10,000	-	16,000	16,000	22,000	6	5
Building C	Cargo Related	Quick Cargo	All Cargo Carriers	10,000	20,000	16,000	36,000	22,000	6	5
Building D	Cargo Related	A1 Freight Services	Third Party Handler	7,500	15,000	2,000	17,000	25,000	10	5
Building E	Cargo Related	Red Express	Integrated Express - Hub	10,000	26,000	47,000	73,000	63,000	9	3
							-			
							-			
							-			
							-			
							-			
							-			
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							-			
Total			Integrated Express	50,000	100,000	80,000	180,000	22,000	7	2
Total			Passenger Airline Belly Cargo	10,000	-	16,000	16,000	22,000	6	5
Total			All Cargo Carriers	10,000	20,000	16,000	36,000	22,000	6	5
Total			Third Party Handler	7,500	15,000	2,000	17,000	25,000	10	5
Total			Combi Carriers (Passenger and Freighter)	-	-	-	-	-	-	-
Total			Integrated Express - Hub	10,000	26,000	47,000	73,000	63,000	9	3
Total			Vacant	-	-	-	-	-	-	-
Total			Non Cargo Related	-	-	-	-	-	-	-
Total				87,500	161,000	161,000	322,000	154,000	38	20

Air cargo facilities are divided into five categories representing each of the types of cargo carriers operating on airports today. Air cargo facilities are commonly occupied by integrated express carriers such as UPS, FedEx Express, and DHL; Passenger Airlines (Belly Cargo Carriers) such as American Airlines, Delta Air Lines and United Airlines; All Cargo Carriers, which operate only freighter aircraft and include CargoLux and Centurion Air Cargo; and Combination (Combi) carriers which operate both passenger aircraft and freighter aircraft. The inventory also allows input for Third Party Handlers; examples include Swissport and Worldwide Flight Services. Third Party Handlers are contracted with passenger and cargo airlines and provide freight and baggage handling and aircraft handling. Integrated express carrier facilities are divided into two types to distinguish between hub and non-hub facilities.

The model allows inputs for nine attributes of air cargo building facilities these include:

Cargo Building Name – The building name may be the recognized name of the building by the airport sponsor, which may be that of the dominant tenant, of the developer or perhaps simply a building number. The choice should reflect what is most commonly understood by the airport staff and relevant constituents.

Usage – Allows for input of type of usage such as cargo related, non-cargo use, or vacant.

Tenant Name – Enter the name of the organization assigned to the space. If the space is unoccupied enter “vacant.”

Tenant Type – By clicking on the cell the user can enter one of the five categories of cargo occupants or carriers operating on airports today. The user may also select “vacant” for unoccupied space or “non-cargo related” for tenants that may not be affiliated with cargo activity. The selections include:

- Integrated Express,
- Passenger Airline Belly Cargo,
- All Cargo Carriers,
- Third Party Handlers,
- Combi Carriers (Passenger and Freighter),
- Integrated Express – Hub,
- Vacant, and
- Non Cargo Related.

Building Space (sf) – Building space includes all space under roof including warehouse and office space. A portion of a warehouse building can be entered into the inventory data sheet under the appropriate category. For example, if an integrated express carrier occupies the north half of a building and passenger carriers occupy the south half, space occupied by the integrated express carrier must be entered as an integrated express on the inventory sheet while space occupied by the passenger carriers must be entered as a passenger carrier on the inventory sheet but the same building name should be used.

Dedicated Ramp/Aircraft Parking Area (sf) – Air cargo buildings often have aircraft apron associated with it. For this model, air cargo aircraft apron is divided into two types: aircraft hardstand or parking apron, and ground service equipment (GSE) storage apron. Aircraft parking on cargo apron is typically demarcated with pavement markings such as the taxi line, nose wheel indicators, hardstand boundaries and engine intake markings.

Dedicated Ground Service Equipment Storage (sf) – Air cargo apron is nearly always utilized to store equipment, to move air cargo and to transfer it to/from aircraft. This area is also used for maneuvering equipment to and from the warehouse and aircraft. Paved apron which is not assigned to the regular parking of aircraft is considered the GSE Storage area for modeling purposes. Enter values in square feet. Most passenger airlines do not require aircraft parking ramp dedicated to their cargo warehouse since their aircraft park at the passenger terminal. However, passenger airlines (or their handlers) do require pavement space to store GSE as well as maneuver equipment. The model requires input for GSE space for passenger carrier cargo buildings.

Total Apron (sf) – This cell sums the area (sf) values for Aircraft Parking Area and GSE.

Landside Truck and Auto Parking (sf) – Cargo buildings typically have paved parking on the landside area of the building. This paved area allows parking primarily for trucks dedicated to truck docks but also allows space for employee and customer parking, as well as truck maneuvering.

Number of Landside Truck Docks/Doors – An inventory of landside truck docks and doors is necessary to determine if cargo buildings have sufficient entry points for cargo.

Number of Airside Truck Docks/Doors – Entry points are also needed on the airside of the building in order for vehicles to have access to the aircraft ramp. A count of the number of vehicle doors on the airside of the building (accessing the ramp and GSE area) is needed for the model.

Note – It is important to point out that prior to conducting the inventory airport planners will likely need to work in concert with airport real estate/properties staff to decide whether some cargo buildings are worth including in the cargo inventory if they are in poor condition and beyond repair, poorly designed for today's cargo industry requirements or have evolved into re-purposed facilities; in that they no longer serve the air cargo industry.

Step 2: Enter Air Cargo Volume Data

A worksheet titled Base Year Cargo Volume allows for an airport's annual air cargo tonnage to be entered into the model.

Figure 12-2 Entering Base Year Air Cargo Volume Data. (SOURCE: CDM Smith.)

Annual Tons - Base Year		
2013		
Total Annual Tonnage (In US tons)		
100,000.0		
Tonnage Market Share (US Tons)		Annual Tonnage
Integrated Express	44%	44,000.0
Passenger Airline Belly	16%	16,000.0
All Cargo Carriers	10%	10,000.0
Third Party Handler	30%	30,000.0
Combi Carriers (Passenger and Freighter)	0%	0.0
Integrated Express Hub	0%	0.0
	100%	100,000.0
Metric Ton Conversion Tool		
2,000.0	Metric Tons	
2,204.6	Short Tons	

Base Year – Enter the Base Year of the total annual tonnage (enplaned and deplaned) for the subject airport. (In U.S. Short Tons). An airport's base year may be calendar year or fiscal year.

Depending on the purpose of the modeling exercise it may also be base year data identified in the airport's most recent master plan.

Total Annual Tonnage (In US tons) – Enter the total annual tonnage (enplaned and deplaned) for the subject airport.

Tonnage Market Share (US Tons) – Annual air cargo tonnage needs to be entered by market share of each category of carrier. Carriers include: Integrated Express carriers such as UPS, FedEx Express, and DHL; Passenger Airlines (Belly Cargo) such as American Airlines, Delta and United; All-Cargo Carriers, which operate only freighter aircraft, including CargoLux and Centurion Air Cargo; Third Party Handlers; and Combination (Combi) carriers. Also, some airports in the U.S. have integrated express carrier hub facilities and a market share allowance is available in the model for these.

Enter market share of annual tonnage for each carrier type operating on the airport, i.e. 75 percent for integrated express carriers.

Metric Tonnage Conversion – Airports may measure air cargo in metric tons. There is a metric tonnage to U.S. short tons conversion calculator at the bottom of the worksheet.

Step 3: Enter Forecasted Air Cargo Volume Data

A worksheet titled **Forecasted Cargo Volume** allows for an airport's air cargo tonnage forecast to be entered into the model. The model allows for volumes to be input at 5-year, 10-year and 20-year increments which are typically presented in an airport master plan as the preferred air cargo tonnage forecast. Total forecasted annual tonnage will need to be entered from an existing master plan or an updated air cargo tonnage forecast for the subject airport.

Figure 12-3 Entering Forecasted Air Cargo Volume Data. (SOURCE: CDM Smith.)

	Total Annual Tonnage in US Tons
Forecasted Year 5 Annual Tonnage	100,000.0
Forecasted Year 10 Annual Tonnage	120,000.0
Forecasted Year 20 Annual Tonnage	140,000.0

Market Share Assumption	Base Year	5-Year	10-year	20-year
Integrated Express	44%	40%	40%	40%
Passenger Airline Belly	16%	20%	20%	20%
All Cargo Carriers	10%	10%	10%	10%
Third Party Handler	30%	30%	30%	30%
Combi Carriers (Passenger and Freighter)	0%	0%	0%	0%
Integrated Express Hub	0%	0%	0%	0%
		100%	100%	100%

Market Share Assumption – Assumptions for annual market share need to be input into the model on this worksheet. The subject airport's master plan forecast may include this information. If unknown, market share assumptions can be held constant at base year levels throughout the 20-year planning period or they can follow historic trends, i.e. integrated express carriers are gaining one percent market share annually at the airport. Airport planners may find alternate methods of determining their forecasted market share based in information gathered during their inventory and data collection effort. Market share needs to be applied to Integrated Express, Passenger Airline (Belly Cargo), All-Cargo Carriers, Third Party Handler, Combi Carriers (Passenger and Freighter), and Integrated Express Hub (if applicable). If a specific carrier type is not anticipated to operate at the airport during the 20-year planning period, the assumption would remain zero percent over the period. It should be noted that the Base Year column in this worksheet is linked to the base year market share inputs on the Base Year Cargo Volume worksheet**.**

Step 4: Facility Size Ratio Inputs

A worksheet (tab) titled Ratios-Matrix provides air cargo throughput ratios. The model utilizes these ratios to estimate facility size required/recommended to accommodate air cargo traffic (tonnage). A tons-to-square-foot ratio is used to derive cargo building/warehouse space, ramp space, and GSE storage space, which are presented in the Domestic Report and the International Gateway Report tabs. Total apron space is the sum of ramp and GSE storage. These ratios are used to ascertain whether facilities are adequate for the base year as well as for forecasted years. Facility ratios are applied to air cargo tonnages for Integrated Express, Passenger Airline (Belly Cargo), All Cargo Carriers, Third Party Handlers, Combi-Carriers (Passenger and Freighter), and Integrated Express Hub (if applicable).

The Ratios-Matrix worksheet provides default ratios (Rows 13 to 22) that are based on the research of over 400 U.S. air cargo facilities (cargo bays and buildings) for the ACRP 03-24 project and the annual cargo handled within them. Adjustments were made related to unoccupied space and facilities, for instance where two airlines had recently merged. Airport planners using this tool however may find it advantageous to conduct their own research to derive ratios suitable to their airport's air cargo facilities. If a planner chooses to adjust the ratios it must take place in the corresponding ratio inputs (salmon colored cells) on the Ratios Matrix tab. These inputs affect the cargo facility sizes presented in the Domestic Report and International Gateway Report tabs. If the planner choses to reenter the default values they are located in rows 13 to 22 for reference. The ACRP Air Cargo Facility Planning Guidelines provide more detail on how to collect and analyze air cargo throughput data. The following section provides additional detail on the Ratios-Matrix worksheet:

Ratio Inputs (Tons/Square Feet) – this table allows the airport planner to input the facility ratios for the subject airport. These ratios are then utilized within the model for ascertaining current and future warehouse, aircraft ramp, GSE storage, and truck parking facility sizes.

Default Ratios Based on ACRP 03-24 Research (Tons / Square Feet) – this table provides ratios based on air cargo facility research related to this study. These are suitable for use when the airport's own utilization ratios are unknown. However, for more accurate ratio inputs, it is strongly suggested that the airport planner conduct their own research to derive their airport's throughput ratios.

Range Of Tons/Sf Based on ACRP 03-24 Research – this table provides an estimated range of throughput ratios that airports planners may derive from their analysis. There will always be exceptions to the rule but these ratios provide general guidelines. Any ratios outside these parameters should only be considered with additional scrutiny.

Figure 12-4 Facility Size Ratio Inputs. (SOURCE: CDM Smith.)

	A	B	C	D	E	F	G	H
2		RATIO INPUTS (Tons/Square Feet)	Integrated Express	Hub-Integrated Express	Passenger Airline (Belly Cargo)	All Cargo Carriers	Third Party Handler	Combi Carriers (Passenger and Freighter)
3		**Warehouse**						
4		Domestic	0.92	1.00	0.64	0.81	0.81	0.81
5		International Gateway	0.37	1.00	0.64	0.81	0.81	0.81
7		**Aircraft Parking Ramp**						
8		Domestic	0.40	0.20		0.40	0.40	0.40
9		International Gateway	0.40	0.20		0.91	0.91	0.91
10		**GSE Storage**						
11		General (Domestic or Int'l)	0.57	0.20	0.36	1.11	1.11	1.11
13		DEFAULT RATIOS BASED ON ACRP 03-24 RESEARCH (Tons / Square Feet)	Integrated Express	Hub-Integrated Express	Passenger Airline (Belly Cargo)	All Cargo Carriers	Third Party Handler	Combi Carriers (Passenger and Freighter)
14		**Warehouse**						
15		Domestic	0.92	1.00	0.64	0.81	0.81	0.81
16		International Gateway	0.37	1.00	0.64	0.81	0.81	0.81
18		**Aircraft Parking Ramp**						
19		Domestic	0.40	0.20		0.40	0.40	0.40
20		International Gateway	0.40	0.20		0.91	0.91	0.91
21		**GSE Storage**						
22		General (Domestic or Int'l)	0.57	0.20	0.36	1.11	1.11	1.11
24		RANGE OF TONS/SF BASED ON ACRP 03-24 RESEARCH	Integrated Express	Hub-Integrated Express	Passenger Airline (Belly Cargo)	All Cargo Carriers	Third Party Handler	Combi Carriers (Passenger and Freighter)
25		**Warehouse**						
26		Domestic	.46 to 1.84	.40 to 1.80	.32 to 1.28	.41 to 1.63	.41 to 1.63	.41 to 1.63
27		International Gateway	.19 to .74	.40 to 1.80	.32 to 1.28	.41 to 1.61	.41 to 1.61	.41 to 1.61
29		**Aircraft Parking Ramp**						
30		Domestic	.20 to .8	.15 to .4		.20 to .8	.20 to .8	.20 to .8
31		International Gateway	.20 to .8	.15 to .4		.46 to 1.82	.46 to 1.82	.46 to 1.82
32		**GSE Storage**						
33		General (Domestic or Int'l)	.29 to 1.15	.15 to .4	.18 to .71	.55 to 2.22	.55 to 2.22	.55 to 2.22

Ratio Inputs – Ratios for each carrier type are provided that take their unique cargo demands and operations into consideration. Ratios are provided for Integrated Express, Passenger Airline (Belly Cargo), All-Cargo Carriers, Third Party Handler, Combi-Carriers (Passenger and Freighter), and Integrated Express Hub (if applicable) required to estimate the air cargo tonnage to be entered into the model. Facility ratios are applicable to building space, aircraft parking ramp, and GSE Storage. Also, ratios are available for airports accommodating either domestic or international air cargo traffic (a gateway airport). Passenger Airlines do not require designated air cargo aircraft parking and therefore do not have inputs for ramp area tonnage-to-square-foot ratios (these inputs are crossed out on the table). The GSE storage ratio for both domestic and international gateway airports utilizes the same ton per square foot ratio.

Step 5: Review Truck Parking Ratio Inputs

Truck Parking ratios were derived from ACRP 03-24 research of over 400 air cargo facilities (cargo buildings and parking lots). In the model ratios for truck parking are based on a warehouse's size.

For example, buildings with 50,000 or less require 1.8 square feet of parking space for every one square foot of building space. Ratios can be adjusted by airports planners, should they choose to, in the salmon colored cells in the **Truck Parking Ratios** worksheet. Default ratios are presented on the right while inputs are on the left. These inputs affect the parking facility sizes presented in the Domestic Report and the International Gateway Report tabs.

Figure 12-5 Review of Truck Parking Ratio Inputs. (SOURCE: CDM Smith.)

	Warehouse to Truck Parking Ratio	Default Warehouse to Truck Parking Ratio
	1.8	1.8
Buildings <50,000 sf	1.8	1.8
Buildings 50,000 to 99,999 sf	1.7	1.7
Buildings 100,000 to 199,999 sf	1.2	1.2
Buildings >200,000 sf	1.4	1.4

Step 6: Review Warehouse Truck Dock/Door Ratio Inputs

Air cargo buildings require ample doors and docks for cargo throughput to trucks on the landside of the warehouse and vehicles and aircraft on the airside of the warehouse. Ratios for cargo doors and docks were derived based on analysis of hundreds of cargo buildings. Cargo buildings with less than 50,000 square feet of space require one truck door for every 1,500 square feet of space. For all warehouses, 25 percent of doors are required on the airside of the building while 75 percent are required on the landside. Default values are presented on the right while ratios (in orange cells) are adjustable.

Figure 12-6 Review of Warehouse Truck Dock/Door Ratio Inputs. (SOURCE: CDM Smith.)

	Square Feet to Dock/Door Ratio	Default Square Feet to Dock/Door Ratio	Airside to Landside Ratio		Default
	1,500	1,500			
Buildings <50,000 sf	1,500	1,500	75%	% Landside doors	75%
Buildings 50,000 to 99,999 sf	2,400	2,400	25%	% Airside doors	25%
Buildings 100,000 to 199,999 sf	2,900	2,900			
Buildings >200,000 sf	4,000	4,000			

Step 7: (Optional) Ramp Area Space Utilization during Peak Hour Aircraft Parking

Ramp areas for aircraft parking may experience schedules which require several aircraft to be parked simultaneously adjacent to their designated cargo building facility. The model makes provision for determining aircraft ramp area space utilization based on current and forecasted air cargo aircraft fleet parking during peak hour periods. This module within the model overrides the ramp area sizing by tonnage if the peak hour demand is greater than the tons/sf module. An airport planner desiring to use Peak Hour Aircraft Parking solely to determine aircraft parking space utilization may do so by changing the Tons Per Square Feet ratio to zero in the Ratio-Matrix worksheet which will turn off the override function.

A worksheet titled Peak Hour Aircraft Parking allows for an airport's current and forecasted peak hour cargo aircraft parking to be entered into the model. The worksheet allows for aircraft fleet mix and quantity for Integrated Express, Passenger Airline (Belly Cargo), All Cargo Carriers, Combi Carriers (Passenger and Freighter), and Integrated Express Hub (if applicable). The optimal way to collect this information is for the airport planner to discuss with each air cargo carrier operating on the subject airport to determine their peak hour aircraft parking needs. These carriers can also estimate aircraft parking needs by aircraft type for 5-, 10- and 20-year planning milestones (based on FAA Airport Reference Code [ARC] which takes into consideration wing span and approach speed). Clicking on the Plus symbol on the left side of the worksheet will expand the ARC aircraft list for each carrier type. Enter in the number of aircraft for each aircraft anticipated or currently parked on the ramp at peak hour. Square footage utilization are summed at the bottom of the column. The worksheet marked Ref-Common Air Cargo Aircraft identifies common air cargo aircraft and their FAA ARC code. For example, if an airport has one B757 and two C208 parking at it on a regular basis, the airport planner would enter a quantity of one C-IV aircraft and two A-II aircraft which derives a total of 61,900 square feet of parking stand required.

SAVING THE RESULTS

It is important for the user to save the results for each case analyzed by saving the excel files under a different naming convention for electronic filing and organization purposes. This allows for successive analyses without having to reload the entire model.

Figure 12-7 Ramp Area Space Utilization During Peak Hour Aircraft Parking. (SOURCE: CDM Smith.)

		A	B	C	D	E	F	G	H
	1								
	2	Existing Demand:		Number of		5-year Demand:		Number of	
	3			Aircraft Parked				Aircraft Parked	
	4	FAA ARC	Hardstand	On Ramp		FAA ARC	Hardstand	On Ramp	Total sf
	5	Aircraft Type	Size sf	Simultaneously	Total sf	Aircraft Type	Size sf	Simultaneously	
	6	Integrated Express Carriers							
+	18	Total	Existing Demand:	Integrated Express Carriers	-	5-year Demand: Integrated Express Carriers			-
	19	All Cargo Carriers							
+	31	Existing Demand: All Cargo Carriers			-	5-year Demand: All Cargo Carriers			-
	32	Third Party Handler							
+	44	Existing Demand: Third Party Handler			-	5-year Demand: Third Party Handler			-
	45	Combi Carriers (Passenger & Freighter)							
+	57	Existing Demand: Combi Carriers (Passenger & Freighter)			-	5-year Demand: Combi Carriers (Passenger & Freighter)			-
	58	Integrated Express Hub							
+	70	Existing Demand: Integrated Express Hub			-	5-year Demand: Integrated Express Hub			-
	71								
	72				-				-

Figure 12-8 Ramp Area Space Utilization During Peak Hour Aircraft Parking - Expanded. (SOURCE: CDM Smith.)

	A	B	C	D	E	F	G	H
1								
2	Existing Demand:		Number of		5-year Demand:		Number of	
3			Aircraft Parked				Aircraft Parked	
4	FAA ARC	Hardstand	On Ramp		FAA ARC	Hardstand	On Ramp	Total sf
5	Aircraft Type	Size sf	Simultaneously	Total sf	Aircraft Type	Size sf	Simultaneously	
6	Integrated Express Carriers							
7	A-II	5,100	0	-	A-II	5,100	0	-
8	A-III	14,000	0	-	A-III	14,000	0	-
9	B-II	10,100	0	-	B-II	10,100	0	-
10	B-III	11,400	0	-	B-III	11,400	0	-
11	C-III	36,100	0	-	C-III	36,100	0	-
12	C-IV	51,700	0	-	C-IV	51,700	0	-
13	C-V	72,000	0	-	C-V	72,000	0	-
14	D-IV	58,700	0	-	D-IV	58,700	0	-
15	D-V	76,200	0	-	D-V	76,200	0	-
16	D-VI	125,000	0	-	D-VI	125,000	0	-
17			0	-			0	-
18	Total	Existing Demand:	Integrated Express Carriers	-	5-year Demand: Integrated Express Carriers			-
19	All Cargo Carriers							
31	Existing Demand: All Cargo Carriers			-	5-year Demand: All Cargo Carriers			-
32	Third Party Handler							
44	Existing Demand: Third Party Handler			-	5-year Demand: Third Party Handler			-
45	Combi Carriers (Passenger & Freighter)							
57	Existing Demand: Combi Carriers (Passenger & Freighter)			-	5-year Demand: Combi Carriers (Passenger & Freighter)			-
58	Integrated Express Hub							
70	Existing Demand: Integrated Express Hub			-	5-year Demand: Integrated Express Hub			-
71								
72				-				-

Air Cargo Facility Utilization Reports

Two types of reports are generated in the model for airports serving primarily U.S. domestic cargo and airports serving as international gateways. Each report is differentiated by the utilization ratios found on the Ratio-Matrix tab. Results are presented in tables for each carrier type: Integrated Express, Passenger Airline (Belly Cargo), All Cargo Carriers, Third Party Handlers, Combi-Carriers (Passenger and Freighter) and Integrated Express Hub (if applicable). Existing space is based on the air cargo facility inventory entered on the worksheet titled Cargo Facility Inventory. The Required Space to Meet Demand is based on current annual tonnage, from Base Year Cargo Volume worksheet divided by the corresponding tons to square feet ratio found on the Ratio-Matrix worksheet. The Forecasted Space Utilization are derived by the forecasted annual tonnage, from the Forecasted Cargo Volume tab divided by the corresponding tons to square feet ratio found on the Ratio-Matrix worksheet. Surplus or deficient space and facilities are identified on the right side of the table. Values presented in red font identify deficiencies in space and facility utilization while black font indicates surplus space.

As indicated in the introduction, this model may be used to plan for all cargo facilities on an airport as well as focus on a single cargo building or cargo area on an airport. It may also be used to ascertain the efficiency of a single cargo bay within a cargo building. The Cargo Facility Inventory Tab provides planners the inputs on which cargo facilities they chose to analyze.

Modeling a Single Air Cargo Facility (Building, Apron, and Vehicle Parking) On an Airport

For modeling a single cargo building or area the airport planner need only input the single building into the inventory and identify the tenants by type utilizing the building. Cargo Tonnage entered into the Base Year Cargo Volume tab must only apply to cargo tenants operating in the subject building.

Forecasted cargo volume must also apply only to the tenants anticipated to occupy the building during the forecast period. Market Share must also be provided for both the current and forecasted volumes.

Determining Whether All Air Cargo Facilities Currently Offer Adequate Space

The model may also be used solely for determining whether an airport's current air cargo facilities are providing adequate space. This can be done by completing Steps 1 to 3 and leaving forecasted cargo volumes at base year levels.

SUMMARY

This chapter provides a practical tool for airport planners to understand air cargo demand and facility requirements for their airport. The process flow of the Air Cargo Facilities Planning Model is to gather data about an air cargo terminal's physical components and determine whether the facilities meet current and forecasted demand. With the inventory in hand, along with the facility ratio matrix determined from survey data and estimation factors, the airport planner can go through the model tool, starting with the air cargo tonnage and market share inputs, then follow the typical path of current cargo apron, building/warehouse, trucking facility space for integrated express, passenger carriers and all-cargo carriers/third party handlers. This tool is intended to provide understanding as to why airport planners use certain cargo related ratios and planning factors; it is not intended as a "one-size-fits-all" guidebook of specific metrics for facility demand requirements. The model was developed with the goal to enhance learning and providing a starting point for the airport planner in the air cargo facility requirements analysis.

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ACRONYM GLOSSARY

AAD	Average Annual Day
AASP	Adaptive Airport Strategic Planning
A4A	Airlines for America
ACRP	Airport Cooperative Research Program
ACI	Airports Council International
ACI-NA	Airports Council International-North America
ADP	Airport Development Plan
ADPM	Average Day Peak Month
AIP	Airport Improvement Program
ALP	Airport Layout Plan
AMP	Airport Master Planning
ANCA	Airport Noise and Capacity Act of 1990
APA	Adaptive Policy Approach
APM	Adaptive Policymaking
ARC	Airport Reference Code
ASP	Airport Strategic Planning
BACK	BACK Aviation Solutions
BSC	Balanced Scorecard
CY	Calendar Year
CBD	Central Business District
CCSP	Certified Cargo Screening Program
CLPA	Cargo Load Plan and Analysis System
CMT	Cargo Mega Terminal
CAEP	Committee on Aviation Environmental Protection
CLI	Composite Leading Indicators
CAGR	Compound Annual Growth Rate
CBP	U.S. Customs and Border Protection
CRAA	Capital Region Airport Authority
CRM	Cargo Revenue Management
CSS	Cargo Storage System
DFW	Dallas-Fort Worth
DSP	Dynamic Strategic Planning
EDI	Electronic Data Interchange
EPA	Environment Protection Agency
ETV	Elevating Transfer Vehicles
EU	European Union
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FIRR	Financial Internal Rate of Return
FBO	Fixed Base Operator
FMS	Flight Management Systems
FSP	Flexible Strategic Planning
FNPV	Financial Net Present Value

GDP	Gross Domestic Product
GPS	Global Positioning Systems
GOAA	Greater Orlando Airport Authority
GSE	Ground Service Equipment
HACTL	Hong Kong Air Cargo Terminals Limited
HAS	Houston Airport System
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
KSDB	Known Shipper Database
LEED	Leadership in Energy and Environmental Design
LTL	Less-Than-Truckload
MAT	Million Annual Tons
MOA	Market Opportunity Analysis
MHS	Material Handling Systems
MOU	Memorandum of Understanding
MRO	Maintenance, Repair, and Overhaul
NPV	Net Present Value
NextGen	Next Generation Air Transportation System
NCA	Nippon Cargo Airlines
NPIAS	National Plan of Integrated Airport Systems
OFA	Object Free A+C31reas
O&D	Origin and Destination
PFC	Passenger Facility Charge
PPP	Public Private Partnership
RASP	Regional Airport System Plan
RFID	Radio Frequency Identification
RFS	Road Feeder Service
RS&H	Reynolds, Smith and Hills, Inc.
SIA	Singapore Airlines
SEIR	Supplemental Environmental Impact Report
SAGA	Sustainable Aviation Guidance Alliance
TAF	Terminal Area Forecast
TAMP	Terminal Area Master Plan
TAR	Tonnage per Area Ratio
TS	Transfer Shuttles
TV	Transfer Vehicles
TSA	Transportation Security Administration
ULD	Unit Load Device
USGBC	United States Green Building Council
UPS	United Parcel Service
USPS	United States Postal Service
URS	URS Corporation
WBDG	Whole Building Design Guide
WCO	World Customs Organization

GLOSSARY OF TERMINOLOGY

Air cargo: Freight and mail carried by passenger airlines, integrated express carriers and all-cargo carriers.

All-Cargo Carriers: All-cargo carriers operate airport-to-airport air cargo and freight services for their customers but do not offer passenger service.

Air cargo apron/ramp area: Portions of the airport tarmac designated for air cargo aircraft parking and operations.

Air forwarder: Firm specializing in arranging storage and shipping of merchandise and materials on behalf of its shippers. It usually provides a full range of services including: tracking inland transportation, preparation of shipping and export documents, warehousing, booking cargo space, negotiating freight charges, freight consolidation, cargo insurance, and filing of insurance claims.

Air freight: That portion of air cargo that does not include mail. Air freight ranges in size from parcels weighing several ounces to large shipments weighing thousands of pounds.

Air mail: That portion of air cargo that does not include freight. Typically comprised of letters, parcels and packages.

ARC (Airport Reference Code) classification: The Airport Reference Code (ARC) is a coding system developed by the FAA to relate airport design criteria to the operational and physical characteristics of the airplane types that will operate at a particular airport. The ARC has two components relating to the airport design aircraft. The first component, depicted by a letter, is the aircraft approach category and relates to aircraft approach speed. The second component, depicted by a Roman numeral, is the airplane design group and relates to airplane wingspan. Generally, aircraft approach speed applies to runways and runway length related features. Airplane wingspan primarily relates to separation criteria and width-related features.

Cargo Airports: Cargo airports are dedicated to the movement of air cargo and offer the advantage of uncongested airspace relative to airports with passenger airline service.

Cargo Buildings: Warehouses, buildings, and retro fitted hangars dedicated to facilitating the transport of air cargo on airports.

Cargo Terminal: A cargo terminal is a facility designed to move cargo containers between different transport vehicles for onward transportation. At an airport, the cargo terminal is used to move cargo between aircraft and trucks. Only a few such examples of pure cargo terminals exist in the world, including HACTL's SuperTerminal 1 at Hong Kong International Airport and Emirates' Cargo Mega Terminal at Dubai International.

CFL / LED lighting: A compact fluorescent light bulb (CFL) is a fluorescent light bulb that has been compressed into the size of a standard-issue incandescent light bulb. A light-emitting diode (LED) is a semiconductor device that emits visible light when an electric current passes through it. Both CFL and LED lighting is considered a more efficient energy use.

Consolidation Center/Drop Station: A consolidation center, or drop station, is intended to reduce truck congestion at large international gateway airports by consolidating the loads of multiple trucks at a point well outside the airport prior to transporting to the destination airport.

Converted Hangars/Warehouse: A converted hangar/warehouse is a standalone building originally designed as an aircraft hangar, converted to be used as a warehouse for the storage and transfer of air cargo. DHL's converted warehouse at San Francisco International is a prime example of this type of facility. Brussels Airport is also home to a converted Sabena hangar that was used for air cargo sorting by DHL.

Cross Dock LTL Facility: A cross dock less-than-truckload (LTL) warehouse is a facility where materials from trucks or rail cars are unloaded and directly loaded into outbound trucks or rail cars, with little or no storage in between.

Dedicated truck parking: Parking for truck/trailers on the landside of cargo buildings. Includes spaces in the building's truck bay doors/docks and parking lot truck/trailer spaces.

ETV – Elevating Transfer Vehicle: Specifically designed for the efficient storage and retrieval of ULDs and Air Cargo Pallets. The ETV functions are to store all types of ULDs and Pallets on multiple levels in a cargo building using friction driven or motorized roller decks.

First Line Air Cargo Facilities: First line air cargo facilities have direct airside access and are typically utilized by airlines, and ground handlers who require direct access to the aircraft, usually parked adjacent to the cargo building.

Freighter: Aircraft capable of carrying only cargo.

Ground handler: Businesses which provide aircraft handling services to air cargo and passenger airlines. These businesses assist with the loading and unloading of aircraft, cargo transport and material handling.

GSE (Ground Service Equipment): Tugs, K loaders, push back, trucks, belt loaders, dollies, ULDs and other vehicles and equipment used to service air cargo aircraft.

Heavy Lift Cargo Freighters: Heavy lift cargo freighters are operated by charter cargo airlines such as Volga-Dnepr Airlines and Antonov Airlines, providing specialized heavy lift operations with its fleet of Antonov An-124 and An-225 aircraft, respectively.

Hybrid Non-Conveyables: A hybrid non-conveyables building is a warehouse that is capable of moving bulky or oversize items via forklift. These items are non-conveyable in the sense that they cannot be moved by conveyor systems. Once de-planed, they enter the facility and are sorted then transferred to truck or aircraft for further transport.

Integrated Express Cargo Carriers: Cargo carriers offering door-to-door service typically under one brand. For example, FedEx Express, UPS, and DHL.

Intercontinental Hubs: An intercontinental hub connects two or three continents by air cargo and passenger aircraft and can be located in relatively remote parts of the world, away from dense populations. These airports offer cargo hub capability as well as aircraft service centers for aircraft needing to refuel and change crews.

International Gateways: The gateway functions as a consolidation, distribution, and processing point for international air cargo. To a certain extent, an international air cargo gateway is similar to a hub airport in that the gateway airport is not reliant on the surrounding market area to generate sufficient cargo to justify air cargo related operations.

LEED Certification: Leadership in Energy & Environmental Design (LEED) is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies intended to improve performance in metrics such as energy savings, pollution and waste.

MHS (Material Handling System or sorting system): Equipment installed in an air cargo building to facilitate the movement of air cargo packages, parcels, pallets and ULDs. These include motorized and non-motorized conveyors, roller decks, slides, and lifts.

Multi-tenant facility: An air cargo building/warehouse with several occupants occupying assigned areas in the cargo building.

National Cargo Hubs: The hub is the backbone of an integrated express carrier since it provides connections to each market in the integrator's system. Each day of operation, flights from around the world arrive at the hub. Once at the hub, packages are unloaded, sorted to the appropriate destination market, and then loaded back onto the appropriate outbound aircraft.

Non-integrated, all-cargo carriers: Cargo carriers offering airport-to-airport service such as Atlas, Cargolux, Evergreen, etc. These carriers rely heavily on the air forwarders to transport cargo to and from the aircraft.

Occupants: An air cargo business, carrier, third party provider, or passenger airline which occupies space in an air cargo building.

O&D/Local Market Stations: The criteria for a local market station, or direct air cargo service (origin and destination [O&D] service to an airport's surrounding market area) generally coincide with population centers where there is a concentration of industry, commerce, and transportation infrastructure. These airports represent the "spoke" in a hub-and-spoke air carrier network.

Pallet (cargo): A pallet is a solid wood, metal, or plastic transport structure on which shipments are stacked and wrapped in plastic and netting.

Regional Hubs: Regional hubs serve the region in which they are located by performing the cargo sorting and distribution functions of that specific carrier's primary hub.

Roller/Castor Deck or Floors: Floors designed for the conveying of ULDs within the warehouse or onto the ramp. The roller decks can be motor or gravity operated for the staging of cargo with different dimensions. Ball bearing or castor like inserts in the deck provides a friction free surface.

Passenger Airlines: Air cargo services provided by passenger airlines vary in scope and size from airline to airline, based on the type of aircraft operating within their fleet. Passenger airlines generally provide airport-to-airport service, with freight and mail carried as "belly" cargo.

Passenger Belly Cargo: Cargo loaded into the belly (and tail) compartments of passenger aircraft

Perishables Centers: Perishable centers are specialized facilities designed to handle goods that require refrigeration such as flowers, fruits, vegetables, seafood, and pharmaceutical products. These facilities are often refrigerated or contain large coolers capable of maintaining the desired temperature.

Perishables Storage: Freezer and refrigerated cargo storage facilities.

Second Line Air Cargo Facilities: Second line air cargo facilities may be on the airport premises but do not offer direct airside access. They work well for tenants who do not have aircraft or can access the aircraft through other through-the-fence access points.

Single-Tenant Facility: An air cargo building/warehouse with one occupant occupying the entire facility.

Security Screening: Areas of a warehouse and or equipment designed to screen cargo for security purposes.

Sorting Facility: Sorting Facilities are designed to consolidate and process air cargo, routing it through the appropriate channel for further transport or local delivery. Automated sorting is used by integrators at their hub terminals in order to achieve their desired turnaround times and delivery commitments. These facilities do not necessarily need to be located on the airport.

Surplus Space: Any building space not used on a consistent basis for the handling of air cargo.

Telecommunications Systems: Wi-Fi/Wireless Internet, two-way radio, cellphone/iPhone/iPad technology and devices, public address system/intercoms, and phone landlines.

Third Line Air Cargo Facilities: Third line air cargo facilities are located in areas surrounding airports which may be owned by private landlords but are not directly connected with the airport. Although not on airport property, these facilities offer aviation service providers the proximity to the airport they desire.

Third-Party Developer: Real estate developers which lease airport land and construct air cargo facilities. These firms lease warehouse space to passenger airlines, cargo carriers and integrated express carriers.

Through-The-Fence Gate Airside Access: Security gates in the vicinity of cargo buildings that allow vehicles access from landside to the air cargo ramp/apron.

ULD (Unit Load Device): A unit load device (ULD), is a pallet or container used to load luggage, freight, and mail on wide-body aircraft and specific narrow-body aircraft.

Warehouse: Warehouses are buildings with many different functional definitions depending on the operator's role. Activities that take place in a warehouse relating to air cargo include unloading/breakdown, buildup/loading, import/export document processing, security screening systems, tracking/tracing, inventory/control, perishables refrigeration, product inventory, delivery and receipt, scanning and processing, administration, etc.

APPENDIX A: SURVEYS AND COVER LETTERS

This appendix contains the following documents used for the technical report:

- Airport Planning Department Survey – Cargo Activity PART I
- Airport Planning Department Survey – Cargo Buildings PART II
- Airport Planning Department Survey – Cover Letter
- Air Cargo Business Survey
- Air Cargo Business Survey – Cover Letter
- Air Cargo Business Survey – Air Forwarders
- Air Cargo Business Survey – Air Forwarders – Cover Letter
- Aeroterm Lease Information

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Airport Planning Department Survey – Cargo Activity PART I

General Airport Information

Airport name ______________________________ Airport Code __________

Contact __________________________ E-mail ______________________

Title _____________________ Department _________________________

Air Cargo Activity

1.1 How many cargo and airline carriers operated at your airport in 2011? ______

1.2 For CY 2011, what was the composition of these carriers?

- Number of passenger airlines carrying cargo? ______
- Number of integrated express cargo carriers, including feeder carriers (such as FedEx, UPS, DHL)? ______
- Please list these integrated express cargo carriers:
  ____
- Number of non-integrated, all-cargo carriers (such as Atlas, Cargolux, Evergreen, etc.[this includes passenger airlines with all cargo aircraft, ie Korean)? ______
- Please list these non-integrated cargo carriers.

____

1.3 Total annual inbound tonnage (freight and mail) handled at airport? ______ lbs. or U.S. tons (most recent calendar year)

1.4 Total annual outbound tonnage (freight and mail) handled at airport? ______ lbs. or U.S. tons (most recent calendar year)

1.5 What was the CY 2011 distribution of total cargo carried, by type of aircraft?

DOMESTIC TRAFFIC (please circle the metric used – lbs or tons)

- Enplaned Mail – Passenger aircraft: _________ lbs. or U.S. tons
- Enplaned Freight – Passenger aircraft: _________ lbs. or U.S. tons

- Enplaned Mail – All cargo aircraft: _________ lbs. or U.S. tons
- Enplaned Freight – All cargo aircraft: _________ lbs. or U.S. tons

- Deplaned Mail – Passenger aircraft: _________ lbs. or U.S. tons
- Deplaned Freight – Passenger aircraft: _________ lbs. or U.S. tons

- Deplaned Mail – All cargo aircraft: _________ lbs. or U.S. tons
- Deplaned Freight – All cargo aircraft: _________ lbs. or U.S. tons

INTERNATIONAL TRAFFIC

- Enplaned Mail – Passenger aircraft: _________ lbs. or U.S. tons
- Enplaned Freight – Passenger aircraft: _________ lbs. or U.S. tons

- Enplaned Mail – All cargo aircraft: _________ lbs. or U.S. tons
- Enplaned Freight – All cargo aircraft: _________ lbs. or U.S. tons

- Deplaned Mail – Passenger aircraft: _________ lbs. or U.S. tons
- Deplaned Freight – Passenger aircraft: _________ lbs. or U.S. tons

- Deplaned Mail – All cargo aircraft: _________ lbs. or U.S. tons
- Deplaned Freight – All cargo aircraft: _________ lbs. or U.S. tons

Cargo Buildings and Areas

(If available please provide a schematic, ALP drawing or aerial photo of your airport's air cargo area(s).)

1.6 Are cargo operations (passenger belly and freighter) concentrated in a single/contiguous area at your airport?
Yes ___ No ___ (if "yes" proceed to question 1.11)

1.7. How many designated passenger belly cargo operation areas are at your airport? ______

1.8. Number of total passenger belly cargo warehouses and buildings: ______

1.9. How many designated freighter/integrated express cargo operation areas are at your airport? ______

1.10. Number of total freighter/integrated express cargo warehouses and buildings: ______

1.11. How is air cargo apron/ramp area managed (who charges for its use)?

____Airport managed
____Third party developer
____Occupant of facility
____Other

1.12. Is the ramp/apron area contiguous to the cargo buildings assigned to cargo building occupants or a shared among many users? Assigned ____ Shared ____

1.13 What largest type of aircraft does the cargo facility accept? Please indicate by aircraft model and ARC (Airport Reference Code) classification

____

Air Cargo Facility Plans

1.14 Is your airport planning the expansion or other improvement of an existing cargo facility and/or the development of a new cargo area? Yes ___ No ___
If you answered "No" to question 1.14 please proceed to question 1.26

1.15 If yes, what is the motivation for the planned expansion?

____

1.16 What is the nature of the planned facilities? (please check all that apply)

- The expansion of an existing warehouse ___
- Retrofitting an existing facility for cargo security compliance ___
- A new warehouse within an existing cargo area ___
- Multiple new warehouses in an existing cargo area ___
- A new warehouse in a new cargo area ___
- Multiple new warehouses in a new cargo area ___
- Some combination of the above ___

1.17 Please describe the new facilities.

____

____

1.18 Have the plans been approved? Yes ___ No ___

1.19 What is the projected completion date? ____________

1.20 Please provide the following information for the facility scheduled for earliest completion:

- Warehouse size (square feet): ____________
- Apron size (square feet): ____________
- Area dedicated to screening operations (square feet): ____________

1.21 What is the design of the aircraft anticipated to operate at this facility? (For example, B747-400, ARC D-IV)

____

1.22 Will the new facility be single or multi-tenant?

Single tenant ___ Multiple tenant ___

1.23 Who will develop the facility?

Airport ___
Carrier____
Handler ___
Third-party developer ___
Other___

1.24 What will be the primary utilization, by type of cargo?

Belly-freight – passenger airliner ___
All cargo freighter – non-integrator ___
Mixed cargo – passenger and cargo freighter operations ___
Integrator – “express cargo” ___

1.25 Will the facility have special characteristics? (check all that apply)

Perishables storage -Freezer ___
Perishables storage -Refrigerator ___
Climate control capabilities _____
ULD (Unit Load Device) handling ___
Roller/Castor floors _____
Sorting system ___
MHS (Material Handling System) ___
ETV (Elevating Traversing Vehicle) ___
Telecommunications systems ___
Security screening ___
Green design ___
Other (please specify): ____

Environmental Factors

1.26 Have any of your air cargo facilities received LEED Certification for their energy conservation and other “green” features? Yes ___ No___

1.27 Have you built or modified other non-certified facilities to incorporate energy-efficient features? Yes ___ No ___

1.28 If so, which features were included? (please check)

- Installed skylights ___

- Added warehouse windows ___
- Installed white (reflecting) roof ___
- Installed green roof ___
- Switched to CFL and/or LED lighting ___
- Installed solar panels ___
- Other (describe) ____

Airport Planning Department Survey – Cargo Buildings PART II

Instructions for Questions 2.1 to 2.15.

Airports often have more than one cargo building. For each cargo building located at your airport, please complete questions 2.1 through 2.15. If there are more than three cargo buildings at your airport, please make reproduce questions 2.1 to 2.15 of this survey and complete for additional cargo building.

2.1. For Cargo Building Number ______

- Name of Building (if applicable): _________________________
- Total Square Feet: _____________

2.2 Is this building owned by the airport, the carrier, a ground handler, or a third-party developer?

____

2.3 Does this facility have contiguous access to aircraft apron/ramp? Yes ___ No ___

2.4 How many square feet is the aircraft-ramp area associated with this cargo building? _____________

2.5 How much space in square feet is dedicated to ground service equipment (GSE) (GSE = Ground Service Equipment)? _____________

2.6 Does this facility have dedicated truck parking? Yes ___ No ___

- Number of spaces ______ (including truck bays)

2.7 How many square feet is the truck parking area associated with this cargo building? _____________

2.8 Does this facility have truck docks/doors? Yes ___ No ___

- Number of docks/doors ______

2.9 Does this facility have through-the-fence gate airside access? Yes ___ No ___

- Number of gates ______

2.10 Does this facility have the capability to accommodate increased cargo security protocols? Yes ___ No ___

2.11 If yes, is this capability based on available surplus space? Yes ___ No ___

2.12 Is this a multi-tenant building? Yes ___ No___

2.13 If yes, how many tenants are located within this building? ______

2.14 Does this facility have special characteristics? (check all that apply)

Perishables storage ___
ULD (Unit Load Device) handling ___
Roller/Castor floors _____
Sorting system ___
MHS (Material Handling System) ___
ETV (Elevating Traversing Vehicle) ___
Telecommunications systems ___
Security screening ___
Green design ___
Other (please specify): ____

2.15 Cargo buildings are often designed for more than one occupant. Please complete the table below for each occupant. An example is provided. Note if you have this in another form such as an excel spreadsheet you may submit it in that manner.

	Example	Occupant 1	Occupant 2	Occupant 3	Occupant 4	Occupant 5
Occupant Name	ABC Cargo					
Unit number	Suite 1					
Occupant total square feet	10,000					
Occupant Warehouse: square feet	8,000					
Occupant Office/Administrative: square feet	2,000					
Occupant ramp space: square feet	30,000					
Occupant GSE: Square Feet:	5,000					
Occupant aircraft operations per day	2					
Occupant aircraft parking at peak hour	1					
Aircraft fleet mix operating at this unit? (name aircraft type)	Boeing 757, DC-8					
Is this unit handled by someone other than the carrier (that is, a third-party handler)?	Yes					
If yes, how many carriers?	3					

2.1. For Cargo Building Number ______

- Name of Building (if applicable): ________________________
- Total Square Feet: ____________

2.2 Is this building owned by the airport, the carrier, a ground handler, or a third-party developer?

____

2.3 Does this facility have contiguous access to aircraft apron/ramp? Yes ___ No ___

2.4 How many square feet is the aircraft-ramp area associated with this cargo building? ____________

2.5 How much space in square feet is dedicated to ground service equipment (GSE) (GSE = Ground Service Equipment)? ____________

2.6 Does this facility have dedicated truck parking? Yes ___ No ___

- Number of spaces ______ (including truck bays)

2.7 How many square feet is the truck parking area associated with this cargo building? ____________

2.8 Does this facility have truck docks/doors? Yes ___ No ___

- Number of docks/doors ______

2.9 Does this facility have through-the-fence gate airside access? Yes ___ No ___

- Number of gates ______

2.10 Does this facility have the capability to accommodate increased cargo security protocols? Yes ___ No ___

2.11 If yes, is this capability based on available surplus space? Yes ___ No ___

2.12 Is this a multi-tenant building? Yes ___ No___

2.13 If yes, how many tenants are located within this building? ______

2.14 Does this facility have special characteristics? (check all that apply)

Perishables storage ___
ULD (Unit Load Device) handling ___
Roller/Castor floors _____
Sorting system ___
MHS (Material Handling System) ___
ETV (Elevating Traversing Vehicle) ___
Telecommunications systems ___
Security screening ___
Green design ___
Other (please specify): ____

2.15 Cargo buildings are often designed for more than one occupant. Please complete the table below for each occupant. An example is provided. Note if you have this in another form such as an excel spreadsheet you may submit it in that manner.

	Example	Occupant 1	Occupant 2	Occupant 3	Occupant 4	Occupant 5
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Occupant Office/Administrative: square feet	2,000					
Occupant ramp space: square feet	30,000					
Occupant GSE: Square Feet:	5,000					
Occupant aircraft operations per day	2					
Occupant aircraft parking at peak hour	1					
Aircraft fleet mix operating at this unit? (name aircraft type)	Boeing 757, DC-8					
Is this unit handled by someone other than the carrier (that is, a third-party handler)?	Yes					
If yes, how many carriers?	3					

2.1. For Cargo Building Number ______

- Name of Building (if applicable): ________________________
- Total Square Feet: ____________

2.2 Is this building owned by the airport, the carrier, a ground handler, or a third-party developer?

____

2.3 Does this facility have contiguous access to aircraft apron/ramp? Yes ___ No ___

2.4 How many square feet is the aircraft-ramp area associated with this cargo building? ____________

2.5 How much space in square feet is dedicated to ground service equipment (GSE) (GSE = Ground Service Equipment)? ____________

2.6 Does this facility have dedicated truck parking? Yes ___ No ___

- Number of spaces ______ (including truck bays)

2.7 How many square feet is the truck parking area associated with this cargo building? ____________

2.8 Does this facility have truck docks/doors? Yes ___ No ___

- Number of docks/doors ______

2.9 Does this facility have through-the-fence gate airside access? Yes ___ No ___

- Number of gates ______

2.10 Does this facility have the capability to accommodate increased cargo security protocols? Yes ___ No ___

2.11 If yes, is this capability based on available surplus space? Yes ___ No ___

2.12 Is this a multi-tenant building? Yes ___ No___

2.13 If yes, how many tenants are located within this building? ______

2.14 Does this facility have special characteristics? (check all that apply)

Perishables storage ___
ULD (Unit Load Device) handling ___
Roller/Castor floors _____
Sorting system ___
MHS (Material Handling System) ___
ETV (Elevating Traversing Vehicle) ___
Telecommunications systems ___
Security screening ___
Green design ___
Other (please specify): ____

2.15 Cargo buildings are often designed for more than one occupant. Please complete the table below for each occupant. An example is provided. Note if you have this in another form such as an excel spreadsheet you may submit it in that manner.

	Example	Occupant 1	Occupant 2	Occupant 3	Occupant 4	Occupant 5
Occupant Name	ABC Cargo					
Unit number	Suite 1					
Occupant total square feet	10,000					
Occupant Warehouse: square feet	8,000					
Occupant Office/Administrative: square feet	2,000					
Occupant ramp space: square feet	30,000					
Occupant GSE: Square Feet:	5,000					
Occupant aircraft operations per day	2					
Occupant aircraft parking at peak hour	1					
Aircraft fleet mix operating at this unit? (name aircraft type)	Boeing 757, DC-8					
Is this unit handled by someone other than the carrier (that is, a third-party handler)?	Yes					
If yes, how many carriers?	3					

AIR CARGO BUSINESS LIST

3.1 Please list any on-airport and off-airport air cargo businesses currently operating at or near your airport. These businesses should include all integrated express carriers, all cargo carriers, passenger airlines, air freight forwarders, ground handlers, third party logistics providers (ie. Swissport), third party developers (i.e. AFCO, Lynxs) **Attach additional sheets/directory/association lists as needed.**

On-airport Cargo Business	Contact Name, E-mail & Phone Number	Full Mailing Address & Zip Code	Type of Service Provided
Example: Wings Forwarding	Joe Smith jsmith@wingsforwarding.com 225-555-1212 (phone)	100 Main Street Anywhere, FL 90210	Air Freight Forwarding

Survey Tool Assessment

Please provide feedback on this questionnaire.

How many minutes did it take to complete this survey? ______

Was the survey: too long? ___
too short? ___
just right?___

Was the survey: too detailed? ___
not detailed enough? ___
just right? ___

THANK YOU FOR YOUR COOPERATION

YOU MAY RETURN THE SURVEY BY SCANNING AND EMAILING TO maynardmk@cdmsmith.com and RMiller@areainc.net , or faxing to Robert Miller at AREA at: 312-461-0015

Surface Mailing Address:
Applied Real Estate Analysis, Inc. (AREA)
Attn: Robert Miller
914 South Wabash Avenue
Chicago, Illinois 60605

TRB

Subject: ACRP 03 24 Guidelines for Air Cargo Facility Planning and Development

October 26, 2012

Dear Airport Planner,

The Transportation Research Board, Airports Cooperative Research Program (ACRP) is conducting a study entitled *Guidelines for Air Cargo Facility Planning and Development* (ACRP 03-24). The objective of this research is to develop guidelines for air cargo facility planning and development at airports. Our contact at ACRP is Mr. Larry Goldstein, and I am the Principal Investigator. I am contacting you to invite your airport to participate in this important study.

Attached is a survey to gather information related to air cargo facilities at your airport as well as your airport's air cargo facilities planning strategy. The data collection process will resemble the cargo element of a master plan data collection effort. A survey for your airport planners to complete is attached. Part I collects data on current activity and planned facilities while Part II collects data on existing cargo facilities. **Please complete and return the survey within <u>three</u> weeks of receipt.**

The participation we need from your airport includes completing the survey and providing us a contact list of local air cargo related businesses and government agencies. Contact information for air cargo businesses and related government agencies is requested on the second to last page of the survey. These businesses and agencies will be surveyed by our team as well in a separate survey. Your assistance in notifying the local cargo industry of our effort can be critically important to establishing credibility with them, whether via a newsletter, email, or cargo association meeting.

For more information on the project please visit:
http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3039

Thank you for your assistance and we look forward to hearing from you soon.

Best regards,

Michael K. Maynard

Michael Maynard, CDM Smith

ACRP 03 24 Air Cargo Facility Planning & Development Guidelines Study

Air Cargo Business Survey

General Information

Air Cargo Business Name ___________________________ Airport Code _____________

Contact _________________________________ E-mail ____________________________

Title ___________________________ Department ________________________________

Air Cargo Activity

1. Cargo business type (please check all that apply)

___Passenger Airline

___Integrated Express (FedEx, UPS, DHL, etc,)

___Cargo-only carrier/Freighter

___Freight Forwarder

___3PL provider

___Regional Air Cargo Carrier (Contractor)

___Ground Handler

___Other____________________________________

2. Location of facility: On-Airport? Yes ___ No ___

Off-Airport? Yes ___ No ___ If Yes, proceed to Question 4

3. If on-airport, does your facility have direct access to aircraft apron/ramp?

Yes ___ No ___

If on-airport, please check which best describes your lease agreement/ownership:

___ We lease our building space from the airport.

___ We lease our space from a third-party developer.

___ We own this building and lease the land from the airport.

___ Other ____

Building

4. Does your operation occupy the entire building or do you share the building with other tenants? (please check)

Occupy entire building ___ Other tenants are in this building ___

5. Your operation's warehouse area size, in square feet: ____________

6. Warehouse (peak) ceiling height: ______ feet

7. Of leased space, please estimate the amount of warehouse space actually utilized on average.

______ percent

8. Please estimate the amount of warehouse space utilized during peak periods.
______ percent

9. If your facility has surplus space, is it used for other uses such as vehicle storage, maintenance, GSE etc.? Please describe:

____

____

10. In-bond storage space? Yes ___ No ___ Square feet: ____________

11. Perishables: refrigeration? Yes ___ No ___ Square feet: ____________

    Freezer? Yes ___ No ___ Square feet: ____________

    Climate controlled space? Yes ___ No ___

12. Space dedicated to cargo security/screening? Yes ___ No ___

    Square feet: ____________

13. Does your facility have a mezzanine or loft space? Yes ___ No ___

    Square feet: ____________

    If so, what is it used for? ____

    ____

14. Does this facility have special characteristics? (check all that apply)

    Perishables storage ___
    ULD (Unit Load Device) handling ___
    Roller/Castor floors _____
    Sorting system ___
    MHS (Material Handling System) ___
    ETV (Elevating Transfering Vehicle) ___
    Telecommunications systems ___
    Security screening ___
    Green design ___
    Other (please specify______________________________________

15. Does your facility have racks for storing cargo? Yes ___ No ___

16. Does your facility have dedicated office space? Yes ___ No ___

    Square feet: ____________

17. Does your facility have a customer counter/reception area? Yes ___ No ___

    Square feet: ____________

18. Does your facility have restrooms? Yes ___ No ___

19. Indoor ULD Storage? Yes___ No___ Square feet: ____________

20. Number of truck doors (warehouse floor at grade with parking lot) ____________

21. Number of Truck docks ______

    Sill height (inches) ____________ Dock levelers: Yes ___ No ___

22. Roller floors in warehouse? Yes ___ No ___ Square feet: ____________

23. Forklift use in warehouse? Yes ___ No ___

Parking

24. Parking lot area in square feet? ____________

    Number of truck parking spaces (including truck bays) ________

    Number of employee parking spaces ______

    Number of customer parking spaces ______

    Number of agency parking spaces _________

    Security gate access to apron/ramp adjacent to facility? Yes ___ No ___

Airside

25. Please estimate your facility's total ramp area assigned to your operation.

    Square feet: ____________

26. Number of aircraft related to your operation and their types parking on apron at peak times?

    ____

____

27. How many aircraft rotations (or turns) take place on the ramp assigned to your operation? ______ What is the average turnaround time per aircraft?_________

28. Is there a vehicle- or service equipment storage area (tugs, K loaders, push back, trucks, belt loaders, dollies, ULD storage area)?

    Yes ___ No ___ Square feet: ____________

29. Does the climate your facility is located in require indoor storage of ULDs and vehicles during winter months? Yes ___ No ___

Activity

30. Annual inbound tonnage handled at your facility? _______tons

31. Annual outbound tonnage handled at your facility? ____________ tons

33. Please estimate total annual inbound tonnage handled at this facility that is trucked from airport(s) outside this station's market area. ____________

34. Please estimate total annual outbound tonnage handled at this facility that is trucked to airport(s) outside this station's market area. ____________

35. Peak hour tonnage at your facility? ____________ tons or packages/hour______

36. What are the primary commodity types handled at your facility?

    ____

37. What percentage of your annual enplaned tonnage is considered tail-to-tail transfer? ______ percent

38. Please estimate what percentage of annual tonnage bypasses the warehouse and is trucked or tugged directly to the aircraft apron through the fence/gate?

    ______ percent

39. What (if any) aspect of your facility constrains your operations the most (for example, not enough truck parking, airport access road congestion, ramp congestion, taxiway congestion, etc.)?

    ____

____

40. Number of employees at your facility Full time ______ Part time ______

Environmental Initiatives

41. Have you made any efforts to increase energy efficiency or improve air quality in the facility you occupy? Yes ___ No ___

42. If yes, what steps have you taken? (please check)

- Developed a truck door practices to minimize thermal energy loss ___
- Developed lighting practices to minimize energy loss ______
- Instituted waste recycling ___
- Developed vehicle-idling practices to minimize exhaust fumes/fuel consumption ___
- Other (describe) ____

Technology Factors

43. Which communication technologies does your facility utilize? (check all that apply):

- Wi-Fi/Wireless Internet ___
- Two-way radio ___
- Cellphone/iPhone/iPad technology and devices ___
- Public address system/intercoms ___
- Phone landline ___

Survey Tool Assessment

Please provide feedback on this questionnaire.

How many minutes did it take to complete this survey? ______

Was the survey: too long? ___
too short? ___
just right?___

Was the survey: too detailed? ___
not detailed enough? ___
just right? ___

Thank You for Your Cooperation.

YOU MAY RETURN THE SURVEY POSTAGE PAID MAIL, OR BY SCANNING AND EMAILING TO maynardmk@cdmsmith.com and RMiller@areainc.net , or faxing to Robert Miller at AREA (Applied Real Estate Analysis, Inc.) at: 312-461-0015

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
FIRST-CLASS MAIL PERMIT NO. 20245 CINCINNATI OH

POSTAGE WILL BE PAID BY ADDRESSEE

CDM SMITH
8805 GOVERNORS HILL DR STE 305
CINCINNATI OH 45249-9877

May 21, 2012

Subject: ACRP 03 24 Guidelines for Air Cargo Facility Planning and Development

Dear Air Cargo Business Manager,

On behalf of the Airport Cooperative Research Program (ACRP), your air cargo organization is being asked to participate in an air cargo facility research study. The ACRP is an industry-driven, applied research program that develops near-term, practical solutions to challenges faced by airport operators. ACRP is managed by the Transportation Research Board (TRB) of the National Academies and sponsored by the Federal Aviation Administration (FAA).

The objective of this research is to develop guidelines for air cargo facility planning and development on and near airports, including the collection of necessary data in support of this effort. These guidelines should assist airport operators in crafting effective business policies and development decisions to meet the industry's current and future technological, operational, and security challenges in a cost-effective, efficient, and environmentally conscientious manner. They should also include updated metrics to help guide the overall air cargo development planning process.

The potential beneficiaries of these guidelines would include airport owners and operators, airlines, integrated cargo carriers, cargo handlers, developers, financial institutions, and others linked to the airport community. The guidelines will inform both the protection of land resources required for long-term development as well as provide near-term facilities direction for specific types of users. The Principal Investigator is Mr. Michael Maynard of CDM Smith.

The enclosed survey will allow our research team to better understand current cargo facility occupancy and utilization at a variety of airport environments, as well as to recognize innovative facility design criteria.

Please complete the enclosed survey within the next 10 days of receipt. Should you have any questions regarding the survey, please contact Mr. Michael Maynard at maynardmk@cdmsmith.com or by phone at 513-716-6558.

The survey may be completed and returned via online data entry, postage paid mailer (enclosed), or sent by FAX 312-461-0015.

For more information on the project, please visit:
http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3039.

Thank you for your assistance.

Michael K. Maynard

Principal Investigator, ACRP 03-24

TRB

ACRP 03 24 Air Cargo Facility Planning & Development Guidelines Study

Air Cargo Business Survey

General Information

Air Cargo Business Name ___________________________ Airport Code _____________
Contact _________________________________ E-mail ____________________________
Title ___________________________ Department ________________________________

Air Cargo Activity

1. Cargo business type (please check all that apply)

   ___Freight Forwarder

   ___3PL Provider

   ___Customs Broker

   ___Ground Handler

   ___Other____________________________________

2. Is your facility located on-airport? ______ or off-airport? ______

3. Is your facility at this location office only? _____ or office and warehouse?_____

4. Your operation's warehouse area size, in square feet: _____________

5. Annual cargo tonnage handled at your facility? _______tons

6. Please estimate air cargo's % share of total cargo handled at this facility? ________ % (compared with ocean, rail & truck)

7. Does your business have more than one facility in this market area?__Yes__No

8. If your company is located off-airport please identify how important the following factors are to your operations.

CRITERIA	NOT IMPORTANT				VERY IMPORTANT
Convenient Highway Access	1	2	3	4	5
Property Rental / Lease Rates	1	2	3	4	5
Proximity to Commercial Airport	1	2	3	4	5
Proximity to Customers	1	2	3	4	5
Proximity to Suppliers/Supporting Businesses	1	2	3	4	5
Available Truck Parking	1	2	3	4	5
Warehouse Capacity	1	2	3	4	5
Other____________	1	2	3	4	5

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
FIRST-CLASS MAIL PERMIT NO. 20245 CINCINNATI OH

POSTAGE WILL BE PAID BY ADDRESSEE

CDM SMITH
8805 GOVERNORS HILL DR STE 305
CINCINNATI OH 45249-9877

October 29, 2012

Dear CVG Air Forwarder/Customs Broker,

Our firm, CDM Smith, is conducting a study for the Transportation Research Board, Airports Cooperative Research Program (ACRP) entitled *Guidelines for Air Cargo Facility Planning and Development* (ACRP 03-24). The objective of this research is to develop guidelines for air cargo facility planning and development on and near airports. We are asking air forwarders located on or near CVG to participate by completing a brief survey related to this study. Our primary interest in reaching out to forwarders is to understand their facility building requirements.

I have attached a brief an electronic survey for your response. Please complete the survey electronically and click on the submit button in the upper right corner, the results will automatically returned to me via email. You may also print the survey, complete it and return it via postage paid mail.

Our contact at ACRP is Mr. Larry Goldstein, and I am the Project Manager for the project. Additionally, The Airforwarders Association and FAA was on the selection committee for this study.

For more information on the project please visit:
http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3039

Thank you.

Best regards,

Mike Maynard
mmaynardmk@cdmsmith.com
513.716.6558

FOR**LEASE**

SOUTHWEST FLORIDA INTERNATIONAL AIRPORT

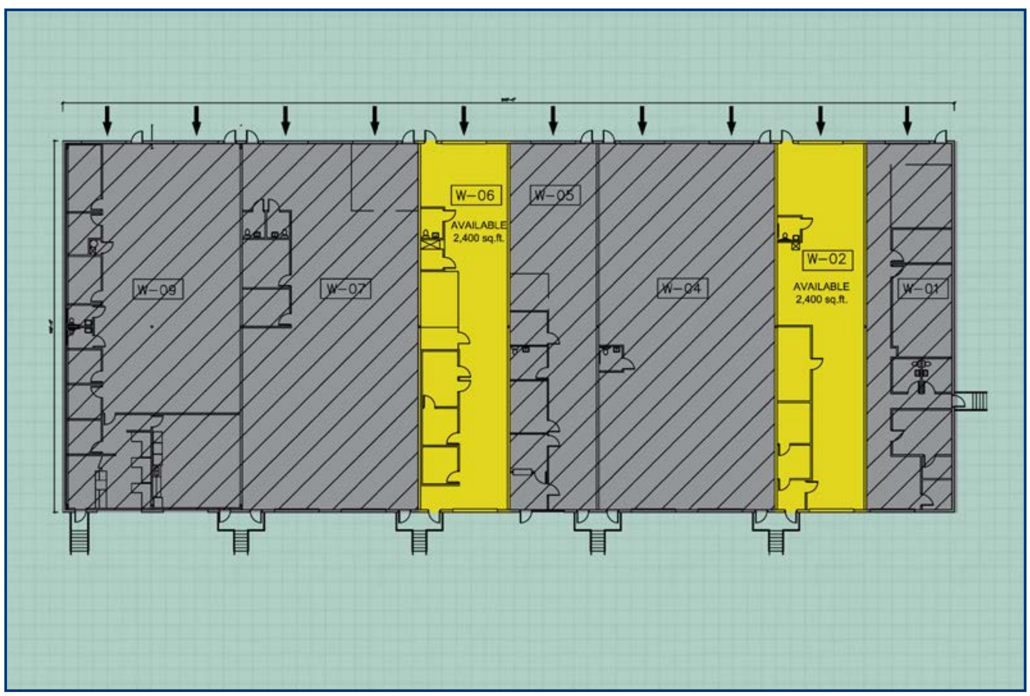
Availability

15960 Chamberlin Parkway
Fort Myers, Florida

Suite W-02
2,400 SF Warehouse

Suite W-06
2,400 SF Warehouse

24' x 100' Bay Size
20' Clear Height
125' Truck Court
1 Dock Door
1 Airside Drive in Door



For More Information

Dustin Gillioz
Director of Leasing
Western Region
Tel: 800-949-7506
Cell: 713-377-1280
dgillioz@aeroterm.com

AEROTERM

APPENDIX B: DETAILED RESPONSE RATE TABLES

General Airport Information

	PART I							
	General Airport Information							
RESPONSE	Airport name	Airport Code	Contact	Email	Title	Department	County/Parish	Climate Zone (DATA NOT FROM SURVEY)
Hard Responses	28	28	27	26	27	26	0	0
% of Usable Data	100%	100%	96%	93%	96%	93%	0%	0%
CDM Smith Est	0	0	0	0	0	0	28	28
% of Usable Data	0%	0%	0%	0%	0%	0%	100%	100%
N/A	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
% of Usable Data	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
Incomplete	*0*	*0*	*1*	*2*	*1*	*2*	*0*	*0*
% of Usable Data	*0%*	*0%*	*4%*	*7%*	*4%*	*7%*	*0%*	*0%*
Usable Data	28	28	27	26	27	26	28	28
% of Usable Data	100%	100%	96%	93%	96%	93%	100%	100%

Air Cargo Activity

	PART I							
	Air Cargo Activity							
	2011 Carrier Composition						Annual Tonnage	
							Inbound	Outbound
	1.1	1.2 For CY 2011, what was the composition of these carriers?					1.3	1.4
RESPONSE	How many cargo and airline carriers operated at your airport in 2011?	Number of passenger airlines carrying cargo?	Number of integrated express cargo carriers, including feeder carriers (such as FedEx, UPS, DHL)?	Please list these integrated express cargo carriers	Number of non-integrated, all-cargo carriers (such as Atlas, Cargolux, Evergreen, etc.[this includes passenger airlines with all cargo aircraft, ie Korean)?	Please list these non-integrated cargo carriers	Total annual inbound tonnage (freight and mail) handled at airport? (Lbs or Tons for most recent year)	Total annual outbound tonnage (freight and mail) handled at airport? (Lbs or Tons for most recent year)
Hard Responses	25	25	26	25	22	13	24	24
% of Usable Data	89%	89%	93%	89%	79%	46%	86%	86%
CDM Smith Est	0	0	0	0	0	0	1	0
% of Usable Data	0%	0%	0%	0%	0%	0%	4%	0%
N/A	*0*	*0*	*0*	*0*	*0*	*5*	*0*	*0*
% of Usable Data	*0%*	*0%*	*0%*	*0%*	*0%*	*18%*	*0%*	*0%*
Incomplete	*3*	*3*	*2*	*3*	*6*	*15*	*3*	*4*
% of Usable Data	*11%*	*11%*	*7%*	*11%*	*21%*	*54%*	*11%*	*14%*
Usable Data	25	25	26	25	22	13	25	24
% of Usable Data	89%	89%	93%	89%	79%	46%	89%	86%

Air Cargo Activity (*continued*)

	PART I							
	Air Cargo Activity							
	2011 Domestic Traffic							
	Enplaned				Deplaned			
	1.5							
	What was the CY 2011 distribution of total cargo carried, by type of aircraft?							
RESPONSE	Passenger Aircraft – Enplaned Mail	Passenger Aircraft – Enplaned Freight	All Cargo Aircraft – Enplaned Mail	All Cargo Aircraft – Enplaned Freight	Passenger Aircraft – Deplaned Mail	Passenger Aircraft – Deplaned Freight	All Cargo Aircraft – Deplaned Mail	All Cargo Aircraft – Deplaned Freight
Hard Responses	19	20	16	19	19	20	16	19
% of Usable Data	68%	71%	57%	68%	68%	71%	57%	68%
CDM Smith Est	0	0	0	0	0	0	0	0
% of Usable Data	0%	0%	0%	0%	0%	0%	0%	0%
N/A	*0*	*0*	*1*	*0*	*0*	*0*	*1*	*0*
% of Usable Data	*0%*	*0%*	*4%*	*0%*	*0%*	*0%*	*4%*	*0%*
Incomplete	*9*	*8*	*12*	*9*	*9*	*8*	*12*	*9*
% of Usable Data	*32%*	*29%*	*43%*	*32%*	*32%*	*29%*	*43%*	*32%*
Usable Data	19	20	16	19	19	20	16	19
% of Usable Data	68%	71%	57%	68%	68%	71%	57%	68%

Air Cargo Activity (*continued*)

	PART I							
	Air Cargo Activity							
	2011 International Traffic							
	Enplaned				Deplaned			
	1.5							
	What was the CY 2011 distribution of total cargo carried, by type of aircraft?							
RESPONSE	Passenger Aircraft – Enplaned Mail	Passenger Aircraft – Enplaned Freight	All Cargo Aircraft – Enplaned Mail	All Cargo Aircraft – Enplaned Freight	Passenger Aircraft – Deplaned Mail	Passenger Aircraft – Deplaned Freight	All Cargo Aircraft – Deplaned Mail	All Cargo Aircraft – Deplaned Freight
Hard Responses	14	13	10	12	13	13	10	12
% of Usable Data	50%	46%	36%	43%	46%	46%	36%	43%
CDM Smith Est	0	0	0	0	0	0	0	0
% of Usable Data	0%	0%	0%	0%	0%	0%	0%	0%
N/A	*1*	*1*	*3*	*2*	*1*	*1*	*3*	*2*
% of Usable Data	*4%*	*4%*	*11%*	*7%*	*4%*	*4%*	*11%*	*7%*
Incomplete	*14*	*15*	*18*	*16*	*15*	*15*	*18*	*16*
% of Usable Data	*50%*	*54%*	*64%*	*57%*	*54%*	*54%*	*64%*	*57%*
Usable Data	14	13	10	12	13	13	10	12
% of Usable Data	50%	46%	36%	43%	46%	46%	36%	43%

Cargo Buildings and Areas

PART I Cargo Buildings and Areas	1.6	1.7	1.8	1.9	1.10	1.11 How is the air cargo apron/ramp area managed (who charges for its use)?				1.12	1.13
RESPONSE	Are cargo operations (passenger belly and freighter) concentrated in a single/contiguous area at your airport? (Y or N)	How many designated passenger belly cargo operation areas are at your airport?	Number of total passenger belly cargo warehouses and buildings	How many designated freighter/integrated express cargo operation areas are at your airport?	Number of total freighter/integrated express cargo warehouses and buildings	Airport Managed	Third Party Developer	Occupant of Facility	Other	Is the ramp/apron area contiguous to the cargo buildings assigned to cargo building occupants or a shared among many users? (A or S)	What largest type of aircraft does the cargo facility accept? Please indicate by aircraft model and ARC (Airport Reference Code) classification
Hard Responses	27	22	22	23	23	21	2	6	0	26	22
% of Usable Data	96%	79%	79%	82%	82%	75%	7%	21%	0%	93%	79%
CDM Smith Est	0	0	0	0	0	0	0	0	0	0	0
% of Usable Data	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
N/A	*0*	*1*	*1*	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
% of Usable Data	*0%*	*4%*	*4%*	*4%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
Incomplete	*1*	*6*	*6*	*5*	*5*	*7*	*26*	*22*	*28*	*2*	*6*
% of Usable Data	*4%*	*21%*	*21%*	*18%*	*18%*	*25%*	*93%*	*79%*	*100%*	*7%*	*21%*
Usable Data	27	22	22	23	23	21	2	6	0	26	22
% of Usable Data	96%	79%	79%	82%	82%	75%	7%	21%	0%	93%	79%

Air Cargo Facility Plans

	PART I								
	Air Cargo Facility Plans								
	1.14	**1.15**	**1.16** What is the nature of the planned facilities? (please check all that apply)						
RESPONSE	improvement of an existing cargo facility and/or the development of a new cargo area? (Y or N)	If yes, what is the motivation for the planned expansion?	The expansion of an existing warehouse	Retrofitting an existing facility for cargo security compliance	A new warehouse within an existing cargo area	Multiple new warehouses in an existing cargo area	A new warehouse in a new cargo area	Multiple new warehouses in a new cargo area	Some combination of the above
Hard Responses	25	10	3	2	3	2	2	2	6
% of Usable Data	89%	36%	11%	7%	11%	7%	7%	7%	21%
CDM Smith Est	0	0	0	0	0	0	0	0	0
% of Usable Data	0%	0%	0%	0%	0%	0%	0%	0%	0%
N/A	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*
% of Usable Data	*0%*	*4%*	*4%*	*4%*	*4%*	*4%*	*4%*	*4%*	*4%*
Incomplete	*3*	*18*	*25*	*26*	*25*	*26*	*26*	*26*	*22*
% of Usable Data	*11%*	*64%*	*89%*	*93%*	*89%*	*93%*	*93%*	*93%*	*79%*
Usable Data	25	10	3	2	3	2	2	2	6
% of Usable Data	89%	36%	11%	7%	11%	7%	7%	7%	21%

Air Cargo Facility Plans (*continued*)

	PART 1 Air Cargo Facility Plans						
	1.17	1.18	1.19	1.20 Please provide the following information for the facility scheduled for earliest completion			1.21
RESPONSE	Please describe the new facilities	Have the plans been approved? (Y or N)	What is the projected completion date?	Warehouse Size (sq. ft.)	Apron Size (sq. ft.)	Area dedicated to screening operations (sq. ft.)	What is the design of the aircraft anticipated to operate at this facility? (For example, B747-400, ARC D-IV)
Hard Responses	9	10	8	7	5	4	10
% of Usable Data	32%	36%	29%	25%	18%	14%	36%
CDM Smith Est	0	0	0	0	0	0	0
% of Usable Data	0%	0%	0%	0%	0%	0%	0%
N/A	*1*	*0*	*1*	*1*	*1*	*1*	*1*
% of Usable Data	*4%*	*0%*	*4%*	*4%*	*4%*	*4%*	*4%*
Incomplete	*19*	*18*	*20*	*21*	*23*	*24*	*18*
% of Usable Data	*68%*	*64%*	*71%*	*75%*	*82%*	*86%*	*64%*
Usable Data	9	10	8	7	5	4	10
% of Usable Data	32%	36%	29%	25%	18%	14%	36%

Air Cargo Facility Plans (*continued*)

	PART I Air Cargo Facility Plans										
	1.22 Will the new facility be single or multi-tenant?		**1.23** Who will develop the facility?					**1.24** What will be the primary utilization, by type of cargo?			
RESPONSE	Single	Multiple	Airport	Carrier	Handler	Third-party developer	Other	Belly-freight – passenger airliner	All cargo freighter – non-integrator	Mixed cargo – passenger and cargo freighter operations	Integrator – "express cargo"
Hard Responses	5	8	8	3	1	2	1	1	5	1	5
% of Usable Data	18%	29%	29%	11%	4%	7%	4%	4%	18%	4%	18%
CDM Smith Est	0	0	0	0	0	0	0	0	0	0	0
% of Usable Data	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
N/A	*1*	*0*	*1*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*
% of Usable Data	*4%*	*0%*	*4%*	*0%*	*0%*	*0%*	*0%*	*4%*	*0%*	*0%*	*0%*
Incomplete	*23*	*20*	*20*	*25*	*27*	*26*	*27*	*27*	*23*	*27*	*23*
% of Usable Data	*82%*	*71%*	*71%*	*89%*	*96%*	*93%*	*96%*	*96%*	*82%*	*96%*	*82%*
Usable Data	5	8	8	3	1	2	1	1	5	1	5
% of Usable Data	18%	29%	29%	11%	4%	7%	4%	4%	18%	4%	18%

Air Cargo Facility Plans (*continued*)

	PART I											
	Air Cargo Facility Plans											
	1.25											
	Will the facility have special characteristics?											
RESPONSE	Perishables storage -Freezer	Perishables storage -Refrigerator	Climate control capabilities	ULD (Unit Load Device) handling	Roller/Castor floors	Sorting system	MHS (Material Handling System)	ETV (Elevating Traversing Vehicle)	Telecommunications systems	Security screening	Green design	Other (please specify)
Hard Responses	4	3	3	5	3	4	3	3	3	4	4	2
% of Usable Data	14%	11%	11%	18%	11%	14%	11%	11%	11%	14%	14%	7%
CDM Smith Est	0	0	0	0	0	0	0	0	0	0	0	0
% of Usable Data	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
N/A	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
% of Usable Data	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
Incomplete	*24*	*25*	*25*	*23*	*25*	*24*	*25*	*25*	*25*	*24*	*24*	*26*
% of Usable Data	*86%*	*89%*	*89%*	*82%*	*89%*	*86%*	*89%*	*89%*	*89%*	*86%*	*86%*	*93%*
Usable Data	4	3	3	5	3	4	3	3	3	4	4	2
% of Usable Data	14%	11%	11%	18%	11%	14%	11%	11%	11%	14%	14%	7%

Environmental Factors

RESPONSE	PART I Environmental Factors 1.26 Have any of your air cargo facilities received LEED Certification for their energy conservation and other "green" features? (Y or N)	1.27 Have you built or modified other non-certified facilities to incorporate energy- efficient features? (Y or N)	1.28 If so, which features were included? (Check all that apply) Installed skylights	Added warehouse windows	Installed white (reflecting) roof	Installed green roof	Switched to CFL and/or LED lighting	Installed solar panels	Other (describe)
Hard Responses	25	24	4	3	3	1	7	3	1
% of Usable Data	89%	86%	14%	11%	11%	4%	25%	11%	4%
CDM Smith Est	0	0	0	0	0	0	0	0	0
% of Usable Data	0%	0%	0%	0%	0%	0%	0%	0%	0%
N/A	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
% of Usable Data	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
Incomplete	*3*	*4*	*24*	*25*	*25*	*27*	*21*	*25*	*27*
% of Usable Data	*11%*	*14%*	*86%*	*89%*	*89%*	*96%*	*75%*	*89%*	*96%*
Usable Data	25	24	4	3	3	1	7	3	1
% of Usable Data	89%	86%	14%	11%	11%	4%	25%	11%	4%

Cargo Buildings Detail

	PART II								
	Cargo Buildings Detail								
	2.1			2.2	2.3	2.4	2.5	2.6	
	Cargo Buildings								
RESPONSE	Name of Building (if applicable)	Additional info from County/City Auditor	Total Square Feet	Is this building owned by the airport, the carrier, a ground handler, or a third-party developer?	Does this facility have contiguous access to aircraft apron/ramp? (Y or N)	How many square feet is the aircraft-ramp area associated with this cargo building?	How much space in square feet is dedicated to ground service equipment (GSE) (GSE = Ground Service Equipment)?	Does this facility have dedicated truck parking? (Y or N)	Number of spaces (including truck bays)
Hard Responses	118	11	103	110	110	80	56	106	85
% of Usable Data	69%	6%	61%	65%	65%	47%	33%	62%	50%
CDM Smith Est.	52	0	41	30	34	37	44	37	39
% of Usable Data	31%	0%	24%	18%	20%	22%	26%	22%	23%
N/A	*4*	*0*	*0*	*0*	*0*	*24*	*21*	*0*	*0*
% of Usable Data	*2%*	*0%*	*0%*	*0%*	*0%*	*14%*	*12%*	*0%*	*0%*
N/A (CDM Smith Est)	*3*	*0*	*0*	*0*	*0*	*3*	*3*	*0*	*0*
% of Usable Data	*2%*	*0%*	*0%*	*0%*	*0%*	*2%*	*2%*	*0%*	*0%*
Incomplete	*4*	*166*	*33*	*37*	*33*	*57*	*74*	*34*	*53*
% of Usable Data	*2%*	*98%*	*19%*	*22%*	*19%*	*34%*	*44%*	*20%*	*31%*
Usable Data	170	11	144	140	144	117	100	143	124
% of Usable Data	100%	6%	85%	82%	85%	69%	59%	84%	73%

Cargo Buildings Detail (*continued*)

PART II – Cargo Buildings Detail – Cargo Buildings	2.7	2.8		2.9		2.10	2.11	2.12	2.13
RESPONSE	How many square feet is the truck parking area associated with this cargo building?	Does this facility have truck docks/doors? (Y or N)	Number of Docks/Doors	Does this facility have through-the-fence gate airside access?	Number of Gates	Does this facility have the capability to accommodate increased cargo security protocols? (Y or N)	If yes, is this capability based on available surplus space?	Is this a multi-tenant building?	If yes, how many tenants are located within this building?
Hard Responses	70	105	96	104	58	49	42	108	80
% of Usable Data	41%	62%	56%	61%	34%	29%	25%	64%	47%
CDM Smith Est.	43	39	41	42	39	1	1	31	24
% of Usable Data	25%	23%	24%	25%	23%	1%	1%	18%	14%
N/A	*3*	*0*	*0*	*0*	*10*	*26*	*28*	*0*	*6*
% of Usable Data	*2%*	*0%*	*0%*	*0%*	*6%*	*15%*	*16%*	*0%*	*4%*
N/A (CDM Smith Est)	*0*	*0*	*0*	*0*	*1*	*17*	*18*	*0*	*1*
% of Usable Data	*0%*	*0%*	*0%*	*0%*	*1%*	*10%*	*11%*	*0%*	*1%*
Incomplete	*64*	*33*	*40*	*31*	*79*	*110*	*116*	*38*	*72*
% of Usable Data	*38%*	*19%*	*24%*	*18%*	*46%*	*65%*	*68%*	*22%*	*42%*
Usable Data	113	144	137	146	97	50	43	139	104
% of Usable Data	66%	85%	81%	86%	57%	29%	25%	82%	61%

Cargo Buildings Detail (*continued*)

	PART II									
	Cargo Buildings Detail									
	2.14									
	Does this facility have special characteristics? (check all that apply)									
RESPONSE	Perishables Storage	ULD (Unit Load Device) handling	Roller/Castor floors	Sorting system	MHS (Material Handling System)	ETV (Elevating Traversing Vehicle)	Telecommunications systems	Security screening	Green design	Other (please specify)
Hard Responses	24	14	18	18	14	8	29	22	3	12
% of Usable Data	14%	8%	11%	11%	8%	5%	17%	13%	2%	7%
CDM Smith Est.	1	1	1	0	0	0	1	0	0	0
% of Usable Data	1%	1%	1%	0%	0%	0%	1%	0%	0%	0%
N/A	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*
% of Usable Data	*1%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*1%*	*0%*
N/A (CDM Smith Est)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
% of Usable Data	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*
Incomplete	*152*	*162*	*158*	*159*	*163*	*169*	*147*	*155*	*170*	*165*
% of Usable Data	*89%*	*95%*	*93%*	*94%*	*96%*	*99%*	*86%*	*91%*	*100%*	*97%*
Usable Data	25	15	19	18	14	8	30	22	3	12
% of Usable Data	15%	9%	11%	11%	8%	5%	18%	13%	2%	7%

Cargo Buildings Detail (*continued*)

RESPONSE	PART II Cargo Buildings Detail **2.15** Cargo Building Occupants Tenants	Occupant Name	Category	Unit Number	Occupant total square feet	Occupant Warehouse: square feet	Occupant Office/Administrative: square feet	Occupant ramp space: square feet	Occupant GSE: Square Feet	Occupant aircraft operations per day	Occupant aircraft parking at peak hour	Aircraft fleet mix operating at this unit? (name aircraft type)	Is this unit handled by someone other than the carrier (that is, a third-party handler)? (Y or N)	If yes, how many carriers?
Hard Responses	406	385	328	261	338	300	270	146	141	108	102	46	67	45
% of Usable Data	93%	88%	75%	60%	78%	69%	62%	33%	32%	25%	23%	11%	15%	10%
CDM Smith Est.	30	54	54	8	79	86	73	78	81	63	55	19	32	1
% of Usable Data	7%	12%	12%	2%	18%	20%	17%	18%	19%	14%	13%	4%	7%	0%
N/A	*0*	*0*	*0*	*1*	*0*	*8*	*9*	*77*	*72*	*98*	*101*	*135*	*112*	*139*
% of Usable Data	*0%*	*0%*	*0%*	*0%*	*0%*	*2%*	*2%*	*18%*	*17%*	*22%*	*23%*	*31%*	*26%*	*32%*
N/A (CDM Smith Est)	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*3*	*3*	*9*	*9*	*49*	*37*	*56*
% of Usable Data	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*1%*	*1%*	*2%*	*2%*	*11%*	*8%*	*13%*
Incomplete	*0*	*6*	*63*	*176*	*28*	*59*	*102*	*218*	*220*	*265*	*279*	*331*	*309*	*399*
% of Usable Data	*0%*	*1%*	*14%*	*40%*	*6%*	*14%*	*23%*	*50%*	*50%*	*61%*	*64%*	*76%*	*71%*	*92%*
Usable Data	436	439	382	269	417	386	343	224	222	171	157	65	99	46
% of Usable Data	100%	100%	88%	62%	96%	89%	79%	51%	51%	39%	36%	15%	23%	11%

Air Cargo Business List

RESPONSE	PART III Air Cargo Business List: Total number of airports that participated in survey	Number of airports that provided a contact list	Total number of air cargo tenants	Number of air cargo tenant contacts provided	Number of addresses/phone #s provided	Number of email addresses provided
Responses	31	14	436	174	174	137
%	100%	45%	100%	40%	100%	79%

APPENDIX C: SAGA SUSTAINABILITY DATABASE

	Practice	Cargo / Ware-housing & Freight Forwarding
	Administrative	
	Policies, Procedures, and Plans	
2	Require that all developers, contractors, and tenants establish a corporate sustainability policy.	✈
3	Develop or adopt sustainable design guidelines, metrics, parameters, and a rating and ranking program (such as the City of Chicago's Sustainable Airport Manual).	✈
4	Develop or adopt a sustainability award recognition program for design, construction, and operations (such as the City of Chicago's Green Airplane Certification Program).	✈
7	Develop detailed technical specifications and standards to implement sustainability measures; include these sustainability specifications as part of contracts.	✈
9	Pursue U.S. Green Building Council LEED Certification (New Construction, Existing Buildings, Commercial Interiors, etc. as applicable) for airport-owned and tenant projects.	✈
10	Develop and implement an Environmental Management System (EMS) or other program to track progress in improving sustainability performance.	✈
11	Establish a sustainability management system with sustainable performance indicators, either in conjunction with an EMS or as a separate program.	✈
13	Require regular sustainability progress reports during design for construction projects (quarterly or at project conception (PDD), 30%, 60%, 90%, and 100% milestones).	✈
17	Clearly define sustainable design goals in requests for qualifications (RFQs), requests for proposals (RFPs), and bid review criteria.	✈
18	Develop and compile a maintenance manual that outlines required schedules and procedures to maintain sustainable performances, such as recommendations for "green" cleaning products, coordination of indoor air filter replacements, comprehensive recycling and composting programs, pavement maintenance, landscaping, etc.	✈
19	Require a LEED building standard and green operating commitment from non-airport controlled buildings that are on airport-controlled land, such as hotels and restaurants.	✈
20	Develop an Environmentally Preferable Purchasing (EPP) Program, utilizing the EPA's EPP website (www.epa.gov/epp/index.htm) to find and evaluate green products and services.	✈
21	Develop and implement an air quality improvement program.	✈
23	Develop and implement a recycling program for day to day airport operations (employees, passengers, concessions).	✈
24	Develop and implement an Asset or Infrastructure Management Plan.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
26	Develop or enhance equipment vehicle maintenance policies, plans, and/or Best Management Practices.	✈
30	Include sustainable practices as part of airport's Minimum Operating Standards requirements.	✈
31	Evaluate sustainable options and practices as part of the Airport Master Plan Update and other planning studies.	✈
32	Develop a "green" landscaping and maintenance practices plan (i.e., limit chemical, water and energy use, use of native materials, etc.).	✈
	Sustainability Meetings, Teams, and Presentations	
49	Provide sustainability training and awareness programs, presentations, and/or meetings for airport tenants.	✈
50	Have tenants create a "tenant environmental handbook" that includes emergency contact numbers, policies, reporting requirements, spill response, handling international waste,, managing and disposing wastes such as fluorescent bulbs, etc.	✈
52	Assign a LEED® AP to review information regarding sustainable concepts and practices with project team members including green building planning, design, construction, operation, maintenance, and tenants.	✈
	Community Outreach	
62	Participate in statewide purchasing alliances with a focus on local procurement.	✈
66	Create an interactive multimedia display (i.e. video, website, etc.) that would engage and educate visitors about the sustainable aspects of completed projects or airport operations.	✈
85	For all design and construction projects, indicate sustainability goals in all interactions with the public.	✈
91	Actively work with local community leaders to attract new clean businesses and educational institutions to the community. Provide incentives and/or establish foreign trade zones.	✈
	Human Resources	
99	Provide training on the airport's sustainable planning, design and construction guidelines, including their basis, the parties responsible for using the guidelines, and the sustainable rating system.	✈
100	Provide appropriate training for the operations and maintenance of airport facilities and systems.	✈
109	Incorporate sustainable practice requirements in standard land lease contract language. Sustainable practices may include operational requirements and/or new building construction requirements to encourage/require tenants to become involved, and to understand the importance of the airport's sustainability program.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
112	Communicate sustainability goals and requirements at pre-bid, bid, project start, update meetings, and review at project closeout.	✈
113	Review sustainable building requirements in specifications with each sub-contractor prior to commencement of work.	✈
	Stormwater Management	
	Erosion and Sedimentation Control	
124	Develop and maintain a Soil Erosion and Sedimentation Control (SESC) plan consistent with EPA regulations on stormwater management for construction activities.	✈
125	Incorporate temporary sedimentation basins, temporary ditch checks, diversion dikes, temporary ditches, sediment traps, silt fences, and/or pipe slope drains into construction plans.	✈
126	Design for/implement curb breaks and drainage ditches, and/or detention basins.	✈
127	Incorporate temporary and permanent soil stabilization techniques, including: compost, hydraulic mulch, hydroseeding, soil binders, straw mulch, and wood mulch.	✈
128	Use lime as an aid for the modification and stabilization of soil beneath roadways and similar construction projects. Using lime can substantially increase the stability, impermeability, and load-bearing capacity of the subgrade.	✈
129	Install rolled mats (organic, biodegradable mulch mats used to reduce erosion) and ensure that they conform to site contours.	✈
130	Monitor water quality impacts by conducting sampling before and during construction, especially after significant storm events.	✈
131	Chip or compost all vegetation for re-use on site and replant disturbed vegetation.	✈
132	Use stormwater Best Management Practices (BMPs) such as water quality swales, rain gardens, dry wells, and constructed wetlands to control stormwater rates.	✈
133	Minimize disturbed landscape areas, and keep pre-existing vegetation intact whenever feasible.	✈
134	Build vertically rather than horizontally to minimize building footprint, to the extent practicable.	✈
135	Locate parking areas underground to reduce impervious area.	✈
136	Achieve permanent soil stabilization in seeded areas by covering all exposed soil surfaces with vegetation. Do not use vegetation that may attract wildlife or impact the safety of aircraft operations on or adjacent to airport operating areas.	✈
137	Use natural fiber geotextiles (permeable fabrics) that are biodegradable.	✈
138	When using vegetation to stabilize soils, make sure a layer of topsoil and compost is present to support growth.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
139	Locate construction lay-down areas and stockpiles on areas that will be paved as part of the construction.	✈
	Stormwater Management, Rate and Quantity	
140	Design projects to ensure no net increase in rate and quantity of stormwater runoff (minimize the amount of impervious surface constructed).	✈
141	Install permeable pavement for roadways, shoulders, non-traffic pavements, maintenance roads, utility yards, and airside and landside parking facilities, where possible.	✈
142	As part of an ongoing construction project, remove/recycle existing pavement that is not required or needed for future use (only if the emissions, erosion, etc. of doing so would not outweigh the stormwater benefits achieved).	✈
143	Install landscaping and plant materials that will reduce runoff rates, where possible.	✈
144	Reduce flow velocities in stormwater conveyance systems to encourage settling of sediments (for later removal).	✈
145	Design storm sewer conveyance systems with reduced diameter pipes.	✈
146	Install "extensive" green roof systems to filter and treat rainwater, evaporate rainfall to the atmosphere, and provide stormwater retention.	✈
147	Collect and reuse stormwater for non-potable uses such as landscape irrigation and building flush systems.	✈
	Stormwater Management, Treatment	
151	Use Best Management Practices (BMPs) that also function as ecological features and provide aesthetic benefits (e.g., constructed wetland systems).	✈
152	Utilize engineered wetlands to treat wastewater, glycol, and other chemicals (off-airport and/or ensure non-wildlife attracting).	✈
153	Incorporate underground infiltration BMPs such as dry wells or perforated drain pipe. These methods avoid creating inundated areas, which attract wildlife.	✈
154	Install first flush systems including slotted edge drains connected to underground holding tanks. First flush sediment would settle in the tanks and be removed at a later date for treatment and/or disposal.	✈
155	Install detention basins, detention ditches, ditch checks and/or other BMP's for effective first flush treatment.	✈
156	Install bioswales along roadways and parking areas to encourage groundwater infiltration of stormwater runoff. These strategies must be designed so that they do not provide habitat for hazardous wildlife.	✈
158	Develop stormwater collection and rain harvesting systems for treatment prior to reuse or discharge.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
162	Install a closed-loop aircraft washrack wastewater recycling system.	✈
	Stormwater Pollution Prevention Plan (SWPPP)	
166	Specify ramp vacuum trucks to recover spent fluids for on-site reclamation.	✈
175	Collect and treat and/or properly dispose of (or recycle, if possible) water used for vehicle, aircraft washing, and other activities conducted outside that generate process wastewater or wastewater.	✈
	Hazardous Waste Spill Prevention/Response	
176	Develop and implement a Spill Prevention Countermeasure and Control Plan (SPCC).	✈
177	Develop and implement an underground storage tank management plan.	✈
178	Develop and implement an above ground storage tank management plan.	✈
179	Establish hazardous waste spill response chain of command with tenant and fuel supplier's planners (i.e., pipeline vs. fuel trucking).	✈
	Deicing Facilities/Operations	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Water Efficiency	
	Water Management Plan	
216	Educate maintenance staff, employees, passenger and tenants about the strategies and practices to make water efficiency a success.	✈
217	Develop a schedule to track life-cycle water usage and cost savings.	✈
	Innovative Wastewater Technologies	
219	Install high-efficiency fixtures and dry fixtures to reduce potable water usage and wastewater volumes.	✈
	Water Use Reduction	
223	Install automatic sensors on toilets, urinals, and on faucets to conserve water.	✈
224	Install water-conserving aerators on lavatories.	✈
225	Install pressure-assisted toilets to conserve water usage.	✈
226	Install dual-flush toilets.	✈
227	Install composting toilets.	✈
228	Install waterless urinals.	✈
229	Install variable flush urinals.	✈
230	Use low-volume, high pressure sprayer nozzles on water hoses used for vehicle washing.	✈
231	Recycle used non-potable water for landscaping, machine washing, urinal and toilet flushing, custodial uses, etc. to the extent allowed by the Safe Drinking Water Act of 1974.	✈
232	Collect and use reclaimed graywater for non-potable needs like building sewage conveyance, cooling tower make-up, irrigation, vehicle maintenance and washing.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
236	Use tank-less hot water heaters (instantaneous hot water heating).	✈
237	Install high-efficiency products certified by U.S. EPA WaterSense program (www.epa.gov/WaterSense/).	✈
238	Utilize stormwater cisterns for capturing rainwater from roofs for irrigation.	✈
240	Install metering networks to facilitate accurate measurement of water use.	✈
	Ground Transportation	
	Public Transportation Access	
241	Provide direct transit access to an existing – or planned and funded – commuter rail or subway/elevated train station (within 0.5 mile).	✈
242	Provide direct access to one or more stops for two or more bus lines usable by airport passengers and employees (within 0.25 mile).	✈
247	Consider the density and the ability to walk and bike to commercial office, retail, and hotel zones on airport property; ensure that sidewalks are present and provide direct, safe access to bus stops, rail stops, and etc.	✈
251	Communicate with local and regional transit authorities to advance multiple transit connection opportunities.	✈
254	Use an off-site delivery consolidation center to reduce delivery traffic.	✈
255	Help implement and support all four elements of the International Air Transport Association's (IATA) Fast Travel Program (www.iata.org/stbsupportportal/fasttravel.htm) including: bags ready-to-go, self-document scanning, self-boarding, and electronic baggage recovery.	✈
256	Help implement and support IATA's Simplifying the Business initiatives including: 2-D BCBP (Bar-Coded Boarding Passes such as on mobile phones), radio-frequency identification (RFID) tags for baggage, in-flight services, parts management, and participation in the Baggage Improvement Program (BIP) audit, or encourage airlines to participate in BIP audits.	✈
	Bicycle Access/Usage	
257	Provide safe bicycle lanes and paths for access to and from the airport.	✈
258	Provide centralized facilities for secure bicycle storage.	✈
259	Ensure bikes remain visible; maintain an image of "bikes belong here" (e.g., signage).	✈
260	Provide incentives for employees to bike to work.	✈
262	Encourage that a minimum of 5% of airport employees use bicycles for all or part of their daily commute.	✈
264	Develop and implement a "ZipBike" or other bike sharing program for employees and passengers to travel between airport facilities.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
	Parking Capacity	
265	Provide incentives such as rebates and/or preferred parking for staff vanpools/carpools for 5% of the total provided parking spaces.	✈
266	Provide infrastructure and support programs to facilitate shared vehicle usage such as carpool drop-off areas, designated parking for vanpools, or car-share services, ride boards, and shuttle services to mass transit.	✈
267	Formulate a multifaceted approach to increasing transit ridership among employees, transit awareness day, guaranteed ride home, etc.	✈
271	Require all airport agencies/vendors to implement discounted vanpooling services.	✈
	Alternative Fuel Vehicles	
272	Provide incentives to airport staff and the public to encourage the usage of alternative fuel vehicles.	✈
273	Establish tax or government credits for support of alternative fuel vehicles.	✈
274	Use alternative fuel service vehicles on airside and landside.	✈
275	Provide low-emitting and fuel-efficient vehicles for 3% of Full-Time Equivalent (FTE) airport occupants AND provide preferred parking for these vehicles.	✈
279	Enhance existing programs for alternative fuel vehicles within the airport operations.	✈
280	Provide preferred parking incentives for alternative fuel vehicles or 20% discounted parking rates.	✈
282	Grant concessions to tenants that have the lowest average fleet emissions.	✈
283	Provide incentives for hybrid/electric airport vehicle purchases/conversions.	✈
289	Replace conventional gasoline-based equipment with alternative-fuel based equipment, including biodiesel, compressed natural gas (CNG), Hythane, hybrid electric, fuel cell, liquid petroleum gas (LPG), or newly developed alternative fuel.	✈
	Reduced Vehicle Idling Plan	
291	Develop a reduced vehicle idling plan for commercial vehicles, construction vehicles, airport service vehicles, tenant vehicles, ground service equipment (GSE), etc.	✈
292	Turn off vehicles if they will be left idle for more than 2 minutes (or other airport-specified time limit).	✈
293	Ensure that no vehicle idling occurs within 100 feet of a sensitive receptor area, such as air intakes.	✈
294	Post no-idling signs to remind vehicle operators to turn off vehicles whenever possible.	✈
295	Install idling and emission limiting/reduction technologies whenever technologically feasible.	✈
296	Require diesel idling restrictions for commercial delivery vehicles.	✈
297	Develop a system to regulate idling; this could include issuing notices or fines for vehicles that are left idle for excessive periods.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
	Roadway Design	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Landscape and Exterior Design	
	Landscape and Exterior Design to Reduce Heat Islands, Non-Roof	
316	Use pavement materials that have a high Solar Reflectance Index (SRI) of at least 29.	✈
317	Substitute vegetated surfaces for impervious surfaces wherever possible. Vegetated areas reduce the heat island effect through plant transpiration.	✈
	Landscape & Exterior Design to Reduce Heat Islands, Roof	
321	Install a vegetated green roof system to reduce the heat island effect and to reduce stormwater runoff from buildings.	✈
322	Install high reflectance/high albedo roofing materials with a high solar reflectance index (SRI), as described in the ASTM E 1980 standard. Low-sloped roofs (slope <= 2:12) should have a SRI value of 78 or above; steep-sloped roofs (slope > 2:12) should have a SRI value greater than 29.	✈
323	Install a Cool Roof Rating Council (CRRC) rated roof product or an Energy Star cool roof with equivalent reluctance and emittance properties (visit www.energystar.gov/).	✈
324	Use a non-asphalt-based single-ply roofing membrane with high emittance properties.	✈
325	Apply high reflectance coating to the surface of a conventional roof membrane.	✈
326	Utilize a combination of vegetated and high albedo roof surfaces.	✈
	Light Pollution Reduction	
327	Minimize site lighting where possible (maintain light use for safety, access, and building identification).	✈
328	Monitor lighting systems regularly to maintain proper illumination and minimize off-site impacts.	✈
329	Meet or provide lower light levels and uniformity ratios than those recommended by the Illuminating Engineering Society of North America (IESNA) *Recommended Practice Manual: Lighting for Exterior Environments (RP-33-99).*	✈
330	Adopt site lighting criteria to maintain appropriate/adequate light levels while avoiding off-site lighting and night sky pollution.	✈
331	Ensure that the maximum candela value of all interior lighting falls within the building (not out through windows) and the maximum candela value of all exterior lighting falls within the property.	✈
332	Model the site lighting using a computer model to establish a baseline level and evaluate benefits.	✈
333	Utilize full cutoff luminaries, low-reflectance, non-specular surfaces and low-angle spotlights for roadway and building lighting.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
335	Where acceptable, use High Pressure Sodium (HPS) lamps instead of Metal Halide (MH) lamps; HPS Lamps produce more lumens per watt, have less mercury content per lamp, and have a greater average rated life expectancy than MH lamps.	✈
336	Use high frequency electronic ballasts with fluorescent 2, 4, and 8-foot Tubular lamps that do not contain mercury.	✈
337	Install self-dimming fluorescent lamp ballasts.	✈
338	Specify strict site lighting criteria and update periodically in conjunction with seasonal daylight fluctuations.	✈
339	Coordinate electrical lighting scenarios with daylight strategies.	✈
341	Ensure that all openings in the building envelope (translucent or transparent) with a direct line of sight to any nonemergency luminaries have shielding that is controlled/closed by an automatic device between 11 p.m. and 5 a.m.	✈
342	Focus light toward the earth to minimize night-sky pollution.	✈
	Water Efficient Landscaping	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Energy Efficiency and Atmosphere	
	Systems Commissioning	
353	Establish and follow systems commissioning requirements consistent with sustainable design to ensure optimal performance of systems. Consider the following systems: central building automation; HVAC equipment; lighting controls and sensors; site lighting; refrigeration systems; vertical transport; building envelope; emergency power generators and automatic transfer switching; uninterruptible power supply systems; life safety systems (i.e., fire alarms); Egress pressurization; lightning protection, domestic and process water pumping and mixing systems; sound control systems; data and communication systems; paging systems; security systems; irrigation systems; plumbing.	✈
354	Implement or have a contract in place to implement best practice commissioning procedures.	✈
355	Review the design intent and the basis of design documentation for proper systems commissioning.	✈
356	Provide the airport owner with a single manual that contains the information required for recommissioning systems.	✈
357	Engage a commissioning team that does not include individuals directly responsible for project design or construction management to evaluate both building and site systems as part of the commissioning plan.	✈
358	For support and ancillary buildings, follow all of the applicable systems commissioning requirements and assemblies.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
359	Establish and follow systems commission requirements for runway lighting and illuminated signage, runway NAVAIDS, runway site lighting systems, traffic signals, pump stations, and oil/water separators.	✈
362	Include recommissioning of affected systems as part of any building modification or addition.	✈
363	Recommission systems when building energy usage deviates from the planned energy usage.	✈
364	Evaluate whether energy systems are sized appropriately.	✈
	Minimum Energy Performance	
367	Meet or exceed the local Energy Conservation Code.	✈
368	Design buildings to comply with ASHRAE/IESNA Standard 90.1-1999.	✈
369	For runways, civil/stormwater and roadways/rail, design site systems to comply with the energy saving intents of ASHRAE/IESNA Standard 90.1-1999.	✈
370	Develop baseline energy consumption (e.g., perform an energy audit of buildings and facilities).	✈
	Optimize Energy Performance	
377	Install metering/monitoring devices and energy management control systems.	✈
380	Install high-efficiency motors and energy systems.	✈
381	Install a motor efficiency controller (such as those made by EcoStart™) in escalators and automated people movers/moving walkways to reduce energy consumption.	✈
382	Provide energy efficient lighting systems.	✈
383	Utilize compact fluorescent light (CFL) bulbs in lieu of incandescent lamps.	✈
384	Organize lighting circuitry and building systems so that individual areas are separately controlled.	✈
386	Install occupancy sensors, either infrared (heat detection), ultrasonic (movement detection), or a combination of both, to control lighting in areas that are intermittently occupied (i.e., rest rooms, storage areas, stairwells, etc.).	✈
388	Install automatic hand towel dispensers in restrooms.	✈
389	Install efficient next-generation hand dryers (such as Dyson AirBlade) instead of conventional dryers or paper towels.	✈
393	Install energy peak shaving units to offset higher demand periods and costs.	✈
395	Use LED "exit" signs and other LED lighting in buildings.	✈
397	Install daylight harvesting control systems, optimize lighting controls, and integrate lighting systems with building automation systems.	✈
398	Use high performance glazing and window systems.	✈
399	Maximize existing levels of insulation and thermal mass for existing, modified, or new buildings.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
400	Seal penetrations, windows, and roof-ceiling-wall intersections. Seal gaps between windows and walls (do not use sealants that contain VOCs).	✈
401	Convert old steam heating systems to modern hot-water heating systems (preferably passive solar water heating systems).	✈
402	Reduce after-hour energy consumption.	✈
409	Use light colored paints and interiors to reflect lighting.	✈
410	Incorporate larger windows on the northern face of a building.	✈
411	Shade southern facing windows with overhangs or deciduous vegetation.	✈
412	Plant coniferous trees to block northwest winds in the winter, reducing heating costs.	✈
413	Incorporate overhead skylighting to increase natural daylight and reduce heating costs during the winter.	✈
414	Use infrared imaging during construction to identify issues with thermal leaks from buildings.	✈
415	Use variable-air-volume systems for cooling to reduce energy use during peak-use conditions.	✈
418	Use Variable Frequency Drive (VFD) motors to control the rotational speed of an alternating current (AC) electric motor. VFD motors can be used in building ventilation systems, pumps, conveyor and machine tool drives, and other systems.	✈
419	Only purchase Energy Star compliant devices (visit www.energystar.gov/).	✈
420	Install gas-fired (versus electric) kitchen equipment, such as ovens, booster heaters, and grills. Equipment should ignite electronically instead of using pilot lights.	✈
421	Install thermal storage systems to decrease peak energy consumption.	✈
422	Connect monitors, printers, and other accessories to a power strip/surge protector. When they are not in use for extended periods, turn off the switch on the power strip to prevent them from drawing power even when shut off.	✈
423	Turn off computer monitors if they are not going to be used for more than 20 minutes (a small surge in energy occurs when a monitor starts up; see www.energysavers.gov/your_home/appliances/index.cfm/mytopic=10070).	✈
424	Turn off both the CPU and monitor if the PC is not going to be used for more than 2 hours (a small surge in energy occurs when a computer starts up; see www.energysavers.gov/your_home/appliances/index.cfm/mytopic=10070).	✈
425	Set up/select a power-down or "sleep mode" feature on the CPU and monitor to reduce energy use.	✈
426	Do not use screen savers since they consume more energy than not using one and/or they may disable power-down or "sleep mode" features.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
427	Purchase and use printers and fax machines with power management features. Turn off the copier(s) at night or purchase a new copier with a power-down or standby feature (see www.energysavers.gov/your_home/appliances/index.cfm/mytopic=10070).	✈
428	Unplug cell phone chargers, fans, coffeemakers, desktop printers, radios, and other equipment that drains energy when not in use.	✈
	CFC, HFC, and HCFC Reduction	
429	Ensure existing and new building HVAC equipment and appliances do not use CFC, HFC, or HCFC refrigerants.	✈
430	For existing HVAC systems, inventory equipment that uses CFC, HFC, and HCFC refrigerants and adopt a fast replacement schedule to eliminate usage of these refrigerants.	✈
432	Maintain equipment frequently to detect leaks.	✈
	Renewable and Alternative Energy	
439	Install solar trash compactors along curbfonts and in remote areas. Solar compactors, such as those made by BigBelly Solar (www.bigbellysolar.com/news/15/palm-springs-solar-powered-trash-compactors-raise-awareness), use solar energy to compact daily waste into neat 40-pound bricks.	✈
440	Install solar photovoltaic panels on buildings and/or at ground level.	✈
441	Install solar trees at the airport. Solar trees are mounted on steel poles topped with photovoltaic (PV) arrays that shift and tilt throughout the day to track the sun.	✈
442	Install synthetic photovoltaic cell-based skin on large roof areas.	✈
443	Explore installing Nanosolar Utility Panels™ (solar panels) that carry 5-10 times more current than typical thin-film panels.	✈
444	Install Nanosolar SolarPly™ light-weight solar-electric cell foil which can be cut to any size.	✈
445	Install solar-thermal powered water heaters.	✈
446	Install solar Trombe walls for passive solar heating.	✈
447	Install building-integrated photovoltaics.	✈
448	Strategically mount solar panels near windows to double as canopies for window shading.	✈
451	Install geothermal-powered hot water heaters (heat pumps).	✈
452	Install geothermal heating and cooling systems.	✈
453	Utilize wind power (wind turbines) where appropriate.	✈
	Measurement and Verification	

	Practice	Cargo / Ware-housing & Freight Forwarding
462	Install continuous metering equipment for the following end-uses: lighting systems and controls; constant and variable motor loads; variable frequency drive (VFD) operation; chiller efficiency at variable loads (kW/ton); cooling load; air and water economizer and heat recovery cycles; air distribution static pressures and ventilation air volumes; boiler efficiencies; building-related process energy systems and equipment; indoor water risers and outdoor irrigation.	✈
465	Require building staff participation during commissioning and testing and balancing activities.	✈
	Indoor Environmental Quality	
	Minimum Indoor Air Quality Performance	
467	Determine potential Indoor Air Quality IAQ problems on-site and locate air intakes away from contaminants such as loading areas, exhaust fans, and cooling towers.	✈
468	Utilize carbon or electrostatic filters, or other particulate control technologies.	✈
	Environmental Tobacco Smoke Control	
471	Locate exterior designated smoking areas away from entries and operable windows.	✈
473	Work with unions in privately leased spaces (such as cargo) to designate these areas as non-smoking.	✈
474	If an interior smoking area is necessary, provide a designated smoking room designed to effectively contain, capture, and remove environmental tobacco smoke (ETS) from the building using a separate ventilation system.	✈
475	Establish zero exposure of non-smokers to environmental tobacco smoke (ETS).	✈
	Carbon Dioxide Monitoring	
476	Provide for real-time control of terminal unit (VAX box) flow rates and total outdoor air flow rates based on carbon dioxide levels.	✈
477	Install a permanent carbon dioxide (CO_2) monitoring system that provides feedback on space ventilation performance in a form that affords operational adjustments in accordance with ASHRAE 62-2001, Appendix D.	✈
	Ventilation Effectiveness	
479	Install air diffusers for all mechanically ventilated spaces, particularly office and terminal spaces, following the recommended design approaches in the ASHRAE 2001 Fundamentals, Chapter 32 *Space Air Diffusion*.	✈
480	Design building ventilation systems that result in an air change effectiveness (εac) greater than or equal to 0.9 as determined by ASHRAE 129-1997.	✈
481	Increase air change effectiveness using displacement ventilation in terminal areas.	✈
482	Use low-face velocity coils and filters to reduce energy loss through air delivery system components.	✈
483	Clean or change furnace filters once a month during the heating season.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
484	Increase air movement in facilities by using ceiling fans.	✈
485	Install trickle ventilators in cargo facilities (small 'openers' concealed within a window or curtainwall's horizontal members), allowing fresh air to 'trickle' into the building and providing natural ventilation without the need for operating windows or sliding doors.	✈
486	Design equipment and ductwork with smooth internal surfaces to minimize the collection of dust and microbial growth.	✈
487	Install relief vents or operable skylights in cargo and other applicable facilities to provide stack effect natural ventilation.	✈
488	For naturally ventilated spaces, demonstrate a distribution and laminar flow pattern that involves not less than 90% of the room or zone area in the direction of air flow for at least 95% of hours of occupancy.	✈
489	Install remote monitoring systems to detect Jet A vapors.	✈
	Low-Emitting Materials	
490	Use zero- or low-VOC (volatile organic compound) adhesives and sealants; consider using water-based sealants which contain no VOCs and can be used on porous or nonporous surfaces.	✈
491	For adhesives and sealants, the VOC content used must be less than the current VOC content limits of South Coast Air Quality Management District (SCAQMD) Rule #1168, AND all sealants used as fillers must meet or exceed the requirements of the Bay Area Air Quality Management District Regulation 8, Rule 51.	✈
492	Do not use adhesives or sealants that use Mercury (PBT).	✈
493	Avoid using fluorescent, compact fluorescent, and LED lights that contain mercury (as well as electrical switches and thermostats).	✈
494	Use zero- or low-VOC field applied paints and coatings.	✈
495	For interior paints and coatings, VOC emissions must not exceed the VOC and chemical component limits of Green Seal's Standard GS-11 requirements.	✈
496	Follow standards and prohibitions documented in South Coast Air Quality Management District (SCAQMD) Rule 1113 (paints and coatings) and applicable source-specific SCAQMD standards.	✈
497	Specify low-VOC carpet systems and/or require that VOC emissions meet or exceed the requirements of the Carpet and Rug Institute's Green Label Indoor Air Quality Test Program.	✈
498	Require that composite wood and agrifiber carpet systems must contain no added urea-formaldehyde resins.	✈
499	Ensure that VOC limits are clearly stated where carpet systems are addressed. Be attentive to carpet installation requirements.	✈
500	Install VOC-free natural linoleum flooring, recycled glass tile, or ceramic tile in lieu of carpet materials that contain VOCs.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
501	Do not install vinyl flooring with high polyvinyl chloride (PVC) content. Carpet containing PVC can release toxic chemicals, including dioxin, into the air; PVC often contains phthalate-based softening agents, which are recognized as reproductive toxins that may contribute to indoor pollution.	✈
502	To ensure a long life cycle of carpeted areas, clean up carpet spills immediately to prevent stains and fungus.	✈
503	Vacuum heavily trafficked areas daily using equipment with powerful suction and a high-efficiency particulate air (HEPA) filtration bag to ensure a long life cycle of carpeted areas.	✈
504	To ensure a long life cycle of carpeted areas, perform extraction cleaning every 6 to 12 months, preferably with hot water or steam.	✈
505	Ensure that all shop finished material meet the VOC emission requirements. Materials to consider are: primed steel, finished metals including aluminum, finished millwork, and finished steel and wood doors and windows.	✈
	Indoor Chemical and Pollutant Source Control	
506	Install separate exhaust and plumbing systems in spaces that are known to use or contain chemicals and hazardous products.	✈
507	Only use electric vehicles in indoor facilities.	✈
508	Prohibit the indoor use of combustion engine-based devices without direct exterior exhaust and make-up air.	✈
509	Use non-absorptive flooring and walls.	✈
510	Use indoor toxic-absorptive vegetation.	✈
511	Use non-toxic cleaning supplies.	✈
512	Remove all equipment containing Polychlorinated Biphenyls (PCB) to reduce risks to occupants from exposure to the material, to reduce the environmental risk from leakage due to deterioration or damage of the equipment, and to reduce the risk of exposure to hazardous combustion by-products in the case of fire.	✈
514	Design buildings to minimize pollutant cross-contamination of regularly occupied areas.	✈
517	Select finish materials, assemblies and equipment, including HVAC equipment, that resist mold growth.	✈
518	Install permanent architectural entryway systems such as grills or grates (preferably over 6 feet long) to prevent occupant-borne contaminants from entering the building.	✈
519	If installing a grate or grill is not practical, hire a contractor to regularly clean mats that track dirt from occupants entering the building.	✈
520	Identify all hazardous products or processes.	✈
521	Install air-tight electrical boxes to minimize air leakage.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
522	Ensure proper ventilations, such as fume hoods, for activities that produce hazardous gasses.	✈
523	Design central locations in terminal and office buildings for storage of concentrated cleaning chemicals and other pollutant sources.	✈
524	Provide utility outlets such as water and electricity for cleaning.	✈
	Controllability of Systems	
527	Install operable windows in areas that are not noise-sensitive.	✈
528	Install task lighting or more light switching zones in offices areas.	✈
529	Install under floor air distribution systems with individual diffusers in office areas.	✈
530	Integrate all building electrical systems.	✈
531	Provide controls for each individual in office spaces for airflow, temperature and lighting of the occupied space, and for the occupants in non-perimeter, regularly occupied areas.	✈
532	Provide areas with varying indoor conditions in terminals, allowing passengers to choose an area with conditions that best match their needs.	✈
533	Integrate micro switches of operable windows with HVAC operation.	✈
534	Integrate occupancy sensors with HVAC operation.	✈
535	Use direct digital control systems for greater accuracy, flexibility, and operator interface compared to pneumatic systems.	✈
	Thermal Comfort	
536	Require the use of (or provide incentives for) centralized pre-conditioned air (PCA) and ground power systems (400 Hz) for gated aircraft. For all new terminal leases, establish lease provisions that require preconditioned air units at all gates with 400 Hz power.	✈
537	Include a requirement for preconditioned air units in all bid documents for terminal and gate design and renovation projects.	✈
538	Install a permanent temperature and humidity monitoring system configured to provide operators with control over thermal comfort performance and the effectiveness of humidification and/or dehumidification systems.	✈
539	Install thermally efficient glass on airport buildings.	✈
540	Fully comply with ASHRAE Standard 55-2004, Thermal Comfort Conditions, including humidity control within established ranges per climate zone.	✈
541	Incorporate air curtains at entrances to airport buildings. Air curtains act as thermal, bug and dust barriers in doorways, saving energy and increasing comfort.	✈
	Daylight and Views	
542	Install natural skylights (such as a Solatube Daylighting System™) which may reduce daylight lighting requirements, especially in airport administrative offices which are usually located on the top floor of the terminal facilities.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
543	Design the building to maximize the amount of daytime sunlight penetrating through windows. Consider: building orientation, shallow floor plates, increased building perimeter, floor-to-ceiling heights, and ceiling configurations.	✈
544	Coordinate daylight strategy with building automation system (BAS) and lighting control system.	✈
545	Provide interior (shades, louvers, blinds) and exterior (overhangs, trees) shading devices/strategies to filter daylight and control glare from sunlight.	✈
546	Enhance architectural features to maximize daylighting and avoid glare problems.	✈
547	Install window tinting film to minimize heat and AC loss through windows, increasing energy savings. Window tinting protects carpets, drapes and furniture from fading, cuts back on the sun's damaging UV rays, makes windows safer by preventing injury and damage from broken glass, reduces glare, and improves privacy.	✈
548	Install photo-integrated light sensors to dim artificial lights when daylight penetrating the building is sufficient.	✈
550	Achieve a minimum Daylight Factor (as defined by LEED 2009) of 25 footcandles (excluding all direct sunlight penetration) in 75% of all regularly occupied areas. (Spaces excluded from these requirements include copy rooms, storage areas, mechanical plant rooms, laundry and other low occupancy support areas).	✈
551	Achieve direct line of sight to vision glazing for building occupants in 90% of all regularly occupied spaces. (Spaces excluded from these requirements include copy rooms, storage areas, mechanical plant rooms, laundry and other low occupancy support areas).	✈
	Noise Transmission	
558	Use laminated glazing to reduce noise transmission.	✈
	Facility Operations	
	Maintenance Equipment	
559	Prior to installing or purchasing equipment, determine the required maintenance procedures for materials and systems specifically with attention to disposal requirements and impacts to indoor environmental quality.	✈
560	Perform vehicle and equipment maintenance indoors, where possible.	✈
561	Design floor drains in indoor maintenance areas (including aircraft maintenance) to discharge to the sanitary sewer and not the stormwater system. Floor drains should discharge into an oil/water separator, which captures oil and other contaminants. The separator should be periodically pumped, and the oil processed for recycling.	✈
562	Perform outdoor maintenance in a designated area paved with impervious concrete. The maintenance area should be a minimum of 50 feet from any storm drain inlet.	✈
563	Maintain and locate Spill Control Kits in areas readily accessible to all maintenance areas.	✈
564	Require aircraft and vehicle wash areas that utilize biodegradable soap.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
	Operation and Maintenance Program	
577	Install HVAC and ductwork products that can be easily cleaned or those that protect against mold/fiber shredding.	✈
578	Consider ease of maintenance when designing lighting systems.	✈
	Furniture, Fixtures, and Equipment	
579	Purchase and reuse existing/recycled furniture.	✈
580	Purchase and install furniture systems that are Greenguard Certified® (www.greenguard.org/).	✈
581	Purchase reused office furniture from local organizations.	✈
	Site Selection and Restoration	
	Brownfield and Contaminated Site Prevention/Redevelopment	
	Exterior Air Quality	
605	Where appropriate, locate recycling bins and dumpsters near aircraft gates to reduce emissions associated with transporting cleaning crews.	✈
610	Require off-peak fueling.	✈
612	Provide a commercial vehicle holding area.	✈
613	Inspect commercial vehicles that operate at the airport twice a year to insure that the vehicles are properly maintained with minimal vehicle emissions.	✈
614	Develop a vehicle inspection program to ensure pollution control devices are in place.	✈
615	Monitor bus/commercial vehicle performance, routes, and frequencies through an Automatic Vehicle Identification (AVI) system to verify performance and fuel economy.	✈
626	Design future airport layout to reduce aircraft delay.	✈
629	Reduce taxiing distances on landing by installing high-speed or rapid exit taxiways.	✈
	Noise and Acoustical Quality	
632	Conduct a noise modeling study.	✈
633	Develop and implement a noise abatement plan.	✈
634	Work with the FAA to enable continuous descent arrivals to reduce emissions and noise.	✈
635	Develop and require the use of area navigation (RNAV) procedures to reduce noise on surrounding land uses.	✈
636	Install a Noise Monitoring System (NMS) for use in managing noise levels.	✈
637	Produce a Fly Quiet Report which scores and awards airport operators.	✈
638	Start a community noise roundtable to help respond to noise issues.	✈
639	Develop and implement a residential sound insulation program if residential units are located in areas exposed to significant aircraft noise.	✈
640	Develop and implement a school sound insulation program if any schools are located within areas exposed to significant aircraft noise.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
641	Establish and maintain a community noise resource website to share information about airport operations and noise mitigation efforts.	✈
642	Install acoustical silencers, barriers, and earthen berms.	✈
643	Replace noisier equipment with quieter units, mufflers.	✈
645	Install a ground run-up enclosure.	✈
646	Locate mechanical equipment and other sources of noise away from areas of occupancy.	✈
647	Install acoustical ceiling tiles, flooring and walls.	✈
648	Install lighting and HVAC systems that produce minimal noise.	✈
649	Install double-pane windows to reduce noise.	✈
	Vegetation and Wildlife Management	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Materials and Resources	
	Waste Reduction	
670	Develop and utilize an off-airport composting facility.	✈
671	Separate food waste from normal waste to utilize for composting (off-site only), biofuels, livestock feed, and other uses.	✈
672	Develop and implement public food waste collection stations.	✈
673	Develop and implement a surplus food program to benefit area food banks by supplying pre-packaged sandwiches, salads, pastries, muffins, cookies, etc.	✈
674	Establish mandates, incentives, and/or inspections to encourage tenants to compost appropriate waste.	✈
676	Conduct a waste composition study (an audit of waste streams) to identify the most common types and amount of waste collected.	✈
678	Utilize Insulating Concrete Forms (ICFs) for decreased waste; ICFs also optimize energy performance and reduce impacts from construction.	✈
681	Encourage the use of local vendors/suppliers.	✈
683	Provide incentives to concessionaires to minimize packaging.	✈
684	Provide recycling services to tenants at no charge and/or assists tenants with setting up their own recycling programs.	✈
685	Set up annual or bi-annual clean-up events that allow tenants, airlines, and airport employees to dispose of bulky, non-hazardous items. The materials are then deconstructed for recycling, donated, or disposed.	✈
686	Provide incentives or requirements for airport businesses to use fabric/reusable bags, biodegradable bags, and/or paper bags instead of plastic bags.	✈
691	Use reusable coffee/tea mugs, glasses, and water bottles instead of paper and Styrofoam cups to reduce waste.	✈
692	Use biodegradable plates and cutlery made from corn and wheat starch.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
693	Use infrared grills for cooking food.	✈
695	Change soap dispensers throughout the airport to units that dispense soap foam versus liquid soap. The soap foam reduces the amount of product being dispensed.	✈
696	Implement a toilet paper roll repurposing (re-rolling) program. Opened, unused toilet paper is often thrown away so that full rolls can be installed to prevent running out of the toilet paper supply prior to the next scheduled cleaning period. The re-rolled toilet paper can be reused at the airport or sent to local homeless shelters.	✈
697	Switch from normal toilet paper rolls to coreless (no cardboard core) toilet paper rolls. The extra space allows for more toilet paper to be held on a single roll, reducing cleaning costs and reducing waste.	✈
700	Instead of a traditional propane garbage incinerator, use a SmartAsh incinerator that requires no fuel burn and incinerates garbage efficiently to meet all applicable standards (www.elastec.com/smartash.html).	✈
	Office Waste Reduction	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Storage and Collection of Recyclables	
726	Recycle aluminum; glass; plastics, paper, newspapers, magazines; phone books and corrugated cardboard.	✈
727	Recycle gas and oil filters; waste gasoline; motor oil; anti-freeze; scrap metal; tires; electrical wiring; electronics; deicing fluid; grease and sludge; hazardous materials and spent solvents; pallets; and wood.	✈
728	Recycle batteries; light bulbs; toner cartridges; and electronics (including monitors).	✈
729	Increase the number of clearly marked, distinct recycling containers available.	✈
732	Designate easily accessible areas for recyclable collection and storage that are appropriately sized and located in a convenient area.	✈
733	Use on-site trash compactors instead of roll-offs to reduce the trips needed to remove municipal solid waste.	✈
737	Utilize cardboard balers, aluminum can crushers, recycling chutes, and other technologies to enhance recycling activities.	✈
739	Recycle aircraft tires, turbine oil, skydrol (an advanced fire resistant aviation hydraulic fluid), engine oil, carpet, glass and metal from light bulbs, and batteries.	✈
740	Maintain cardboard compactors to assist concessionaires with recycling of cardboard.	✈
	Structure and Building Reuse	
742	Re-use existing structures and/or building components.	✈
744	Indicate the strategies for reuse and quantities of reused runway and infrastructure. Reuse refers to existing structures that are left in place, or have been relocated for reuse.	✈
745	Quantify the extent of structure and building reuse.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
746	Remove elements that pose a contamination risk prior to reusing structures.	✈
	Construction Practices	
	Submit a Final Sustainable Construction Project Report	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Construction Scheduling and Sequencing	
753	Expedite the completion of the building envelope to minimize moisture exposure to interior surfaces, thus minimizing the potential for mold.	✈
754	Closely coordinate deliveries of construction materials with scheduled installation times.	✈
755	Use "just in time" delivery of construction materials to reduce staging requirements.	✈
756	To prevent erosion, minimize the extent and duration of bare ground surface exposure.	✈
757	Plan the phases or stages of construction to minimize exposure. Before site disturbance occurs, perimeter controls, sediment traps, basins, and diversions should be in place to control runoff and capture sediments.	✈
	Logistics	
758	Purchase precut and prefabricated components when available and order materials to size in order to reduce waste and haul loads.	✈
759	Ask suppliers to deliver supplies using sturdy returnable pallets and containers. Have suppliers pick up pallets and empty containers.	✈
760	Limit the number of designated concrete washout areas to avoid the expense of cleaning and maintaining several small washout areas.	✈
761	Consider easily stackable units such as cladding systems, curtain walls, steel beams, and etc. that can reduce transportation costs to the site.	✈
762	Order metal decking to the required length and reduce the number of cuts.	✈
763	Use reusable delivery and storage containers where possible.	✈
764	Suggest using a raised floor system, which can reduce data and communication installation costs during initial build-out and allow for easier, more economical moves and space reconfiguration.	✈
765	Adopt a "first-in, first-out" policy to prevent finish materials from becoming out-dated. The first materials delivered to the site are the first ones used on-site.	✈
	Construction Waste Management	
766	Develop and implement a Construction Waste Management Plan.	✈
767	Develop a balanced earthwork plan and keep as much excavated earth on-site as possible to reduce off-site hauling.	✈
768	Develop an inventory of topsoil for potential re-use.	✈
769	Require that all vegetation that has to be removed because of construction be chipped for on-site mulching and composting or used for process fuel (if the full plant or tree cannot be relocated, sold, or donated intact).	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
770	Track and evaluate the following waste for recycling (at a minimum): land-clearing debris, cardboard, metal, brick, concrete, asphalt, plastic, clean wood, glass, gypsum wallboard, carpet, and insulation.	✈
771	Use portable concrete/asphalt crushers or operate concrete crushing/recycling plants on-site to crush chunks of concrete or asphalt into small pieces. This crushed material may then be recycled for use in other construction applications (see http://205.153.241.230/P2_Opportunity_Handbook/7_III_6.html).	✈
773	Provide on-site locations for storing as much excavated rock, soil, and vegetation as possible for reuse.	✈
774	Designate special construction waste containment areas (medical, industrial, pollution.)	✈
775	Designate a permanent central storage area or secondary containment area for construction.	✈
777	If no local markets exist for recycling drywall in the area, recycle non-contaminated drywall by grinding and spreading on open land at the airport at a rate of approx. 5 tons per acre and then tilling into the soil.	✈
778	Designate hazardous waste containment areas.	✈
779	Establish a hazardous waste management plan for all storage and operational use of hazardous materials	✈
780	Donate unused paint to the city's graffiti removal program.	✈
781	Utilize excess asphalt paving to fix surrounding roads, drives, parking lots, etc.	✈
782	Use concrete chunks, old bricks, broken block and other masonry rubble for backfill along foundation walls where permitted.	✈
786	Use large panel formwork systems to reduce concrete waste generated by losses due to damaged formwork, which usually accounts for 30% of the total concrete waste.	✈
791	Reuse items such as electrical boxes, breaker equipment, wall outlets and other electrical equipment where possible.	✈
792	Reuse empty wire spools for other purposes and tasks – they make a great stool during break time.	✈
	Recycled Content	
799	Purchase concrete materials that consist of recycled content, such as aggregate in cast in place concrete, fly-ash in cast in place concrete, and bituminous concrete pavement.	✈
800	Purchase recycled content materials for the following major building components: unit pavers; steel reinforcement; structural steel; miscellaneous steel; steel fencing and furnishings; unit masonry; ductile iron pipe; aluminum products; site generated broken concrete for gabions; railroad rails; railroad ties; railroad track base material; steel doors and frames; aluminum doors and windows.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
801	Purchase recycled content materials for the following internal building components: plaster; terrazzo; acoustical ceilings; drywall; finish flooring including carpet, resilient flooring, and terrazzo; toilet and shower compartments; special furnishes; equipment; sheet metal ductwork; site lighting.	✈
802	Identify the value of both the post-consumer recycled content and the post-industrial content. Recycled content materials shall be defined in accordance with the Federal Trade Commission document, Guides for the Use of Environmental Marketing Claims, 16 CFR 260.7 (e), available at www.ftc.gov/bcp/grnrule/guides980427.htm.	✈
803	For electrical systems, use telecommunications cabling and electrical device wall plates that have a high percentage of recycled plastic.	✈
805	Use rubber, glass, agricultural fibers, and plastic for flooring. These materials are from recycled and reused materials, typically last longer, and are easier to maintain than traditional flooring materials.	✈
806	Install carpet tiles from postindustrial nylon that are reusable and recyclable.	✈
807	Use ceramic tile containing post-consumer or post-industrial waste.	✈
808	During construction, ensure that the specified recycled content materials are installed and quantify the total percentage of recycled content materials installed.	✈
809	Provide fact sheets to designers that include available recycled content materials and the organization's target for each material.	✈
	Local/Regional Materials	
810	Use the following locally/regionally available materials: concrete, asphalt, structural steel, masonry, post-industrial recycled gypsum wallboard, storm system concrete pipes of all sizes, manholes and handholes, electrical ductbanks, cable, gas and water piping, rail tracks, rail ties, rail ballast, landscape material and seed.	✈
811	Establish a goal for the minimum percentage of local/regional materials and products that are manufactured regionally within a radius no greater than 500 miles. Identify the value of local/regional materials so that they can be compared with of the total value of the materials in the task/project.	✈
813	For buildings, specify mechanical, electrical and plumbing equipment and components that meet the regional material goals.	✈
814	During construction, ensure that the specified local materials are installed and quantify the percentage of the local materials installed based on the overall construction cost.	✈
815	Engage the FAA to discuss the use of regional or local suppliers as part of projects that utilize FAA funding and adhere to FAA rules.	✈
	Rapidly Renewable Materials	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
816	Use the following rapidly renewable materials for both permanent and temporary construction materials: poplar OSB and straw board or "agriboard" (formwork for temporary construction and underlayment); bamboo flooring; cork; wool carpets and fabrics; cotton-batt insulation; linoleum flooring; sunflower seed board; wheat grass or straw board cabinetry and others.	✈
817	Install clay roof tiles which are made from abundant raw materials and carry effective heat gain characteristics (for cool climates).	✈
818	Use paper joint tape in lieu of fiberglass tape.	✈
819	Establish an appropriate project goal for renewable materials utilization.	✈
820	Include contact information for the following in project specifications: GreenSpec from Building Green, Inc. (www.buildingreen.com/menus/index.cfm) and Oikos (ww.oikos.com).	✈
821	During construction, ensure that the specified rapidly renewable materials are installed.	✈
	Certified Wood	
822	Establish a Forest Stewardship Council (FSC) certified wood products goal and identify suitable suppliers. This includes, but is not limited to: structural framing and general dimensional framing, flooring, finishes, furnishings, and non-rented temporary construction applications such as bracing, concrete form work and pedestrian barriers.	✈
823	Use FSC products in construction materials and finished products; meet established FSC goals (www.fscus.org/green_building).	✈
824	Use FSC products in temporary construction materials whenever possible (www.fscus.org/green_building).	✈
	Wood Preservatives	✈
826	Prohibit the use of creosote-coated lumber.	✈
827	Do not use chromate copper arsenate (CCA) pressure-treated lumber.	✈
828	Do not use extruded polystyrene (XPS) rigid board insulation.	✈
829	Do not use fiberglass insulation that contains phenol-formaldehyde binders.	✈
	Salvaged Materials and Resources	
830	Advertise salvage activities prior to demolition activities to encourage salvaged materials re-use.	✈
831	Re-use project waste as a resource to another project or donate it to a cooperating agency. This may include concrete, asphalt, clean soil, and other materials (see http://205.153.241.230/P2_Opportunity_Handbook/7_I_A_8.html).	✈
	Planning for Deconstruction, Disassembly, and Flexible Use of Space	
835	Plan for deconstruction, disassembly, and flexible use of space for systems, components, and structures.	✈
839	Purchase ceiling tile and carpeting from companies that recycle and/or reuse deconstructed carpet and tiles.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
840	Detail electrical/utility connections for disassembly; provide instructions.	✈
841	Ensure that electrical/utility connections are accessible to ease upgrades and disassembly.	✈
842	Minimize the use of chemical (adhesive) connectors; instead use friction-based connectors.	✈
843	Specify flexible components of HVAC, electrical and fiber optics, and other wiring.	✈
846	Design AC roof units so additional units may be placed if necessary in the future.	✈
847	Design for additional temperature, electrical, sprinklers and communication zones in a large space so that future renovation work will not disrupt services.	✈
848	Place entrances and corridors to spaces in such a way that future uses may utilize existing egresses.	✈
849	Evaluate the structure and component life cycle prior to purchasing materials/equipment.	✈
850	Create flexible and diverse workspaces to enable expansion.	✈
851	Select fittings fasteners, adhesives and sealants that allow for quicker disassembly and facilitate the removal of reusable materials.	✈
	Construction Vehicle Emissions Reduction	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Reduced Construction Vehicle Idling	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Alternative Transportation During Construction	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Construction Materials Conveying	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Construction Noise and Acoustical Quality	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Foundations	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Other Construction Equipment/Materials	
899	Require Energy Star certified products for temporary and permanent building equipment (visit www.energystar.gov/).	✈
900	Use localized hot water equipment rather than centralized equipment to reduce transmission loss and improve efficiency.	✈
902	Install pipes with acoustic measuring devices to detect vibrations and/or sound waves in pipelines, indicating defects.	✈
903	Require early installation of permanent electrical systems to minimize the number of temporary circuits needed to handle construction activities.	✈
904	Use soundless demolition chemical agents (SCDA) as a substitute for explosives	✈
905	Consider installation of moisture resistant greenboard and mold resistant purpleboard.	✈

	Practice	Cargo / Ware-housing & Freight Forwarding
	Construction Equipment Maintenance	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Emission Inventory and Mitigation	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Construction Indoor Air Quality (IAQ) Management Plan	
913	During construction meet or exceed the recommended Design Approaches of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 1995, Chapter 3.	✈
914	Protect stored on-site or installed absorptive materials from moisture damage.	✈
915	After construction ends and prior to occupancy, conduct a two-week building flush out with 100% outside air.	✈
916	Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and pre-occupancy phases of the building.	✈
917	Sequence the installation of materials to avoid contamination of absorptive materials such as insulation, carpeting, ceiling tile, and gypsum wallboard.	✈
918	Do not operate (or impose strict limits on the operation of) air-handling equipment during construction.	✈
919	If air handlers are used during construction, filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 must be used at each return air grill, as determined by ASHRAE 52.2-1999.	✈
920	Replace all air filter media used during construction at least two weeks prior to building occupancy, subsequent to building flush-out.	✈
921	Filtration media shall have a Minimum Efficiency Reporting Value (MERV) of 13, as determined by ASHRAE 52.2-1999 for media installed after construction.	✈
	Construction Environmental Tobacco Smoke (ETS) Control	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Dust Control	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Construction Lighting	
940	Establish a schedule for when construction lighting is required and develop a policy to reduce lighting when not needed.	✈
941	Reduce construction at night time to minimize lighting impacts and improve safety.	✈
942	Focus construction lighting toward the earth to minimize night-sky pollution.	✈
943	Limit lighting in protected ecological areas to mitigate lighting impacts on wildlife.	✈
	Minimize Site Disturbance During Construction	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Construction Traffic Control	
	None listed for: Cargo / Ware-housing & Freight Forwarding	

	Practice	Cargo / Ware-housing & Freight Forwarding
	Reduce Potable Water Use During Construction	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Tree and Plant Protection	
	None listed for: Cargo / Ware-housing & Freight Forwarding	
	Construction Health and Safety	
966	Develop a site-specific health and safety plan that identifies all potential hazards and steps taken to mitigate accidents.	✈

Source: http://airportsustainability.org/database#

APPENDIX D: GUIDELINES—ROUNDTABLE DISCUSSION REPORT

APPENDIX OVERVIEW

Our team conducted a roundtable discussion at the ACI-NA National Conference held in Calgary, Alberta Canada to gather data from airports via roundtable discussion and one-on-one interviews with airport management and planners. Kitty Freidheim of Freidheim Consulting moderated the roundtable discussion and made every effort to include participants from a cross section of the industry: international gateways, major gateways, integrated carrier airports, and small regional airports. The roundtable discussion was intended to address all aspects of cargo planning and development in a small forum in a more personal and anecdotal way without the formal structure of a survey instrument.

Location: Airport Council International (ACI) World Meeting held in Calgary, Alberta, Canada.

Date: Saturday, September 8, 2012.

Leadership: Ms. Kitty Freidheim of Freidheim Consulting.

Objective: Research efforts included the organization of a roundtable discussion meeting with airport planners, property managers, and air service marketing managers. The goal of the discussion was to gather information related to:

- Trends in the industry
- Market sector growth
- Financing and lease trends
- Recent modal cargo developments
- Changes in the industry
- Emerging entities/industry consolidation
- Adequacy of current data
- Design innovation
- Impacts of new aircraft
- Problems with current processing procedures/Security
- Sustainability
- Environmental regulations

Preparation

Multiple invitations were sent to those attendees who traditionally participate in the ACI Cargo Committee meetings. An attendees/registration list was provided by ACI. It was used to develop a list of potential attendees. Mike Maynard and Kitty Freidheim developed a list of airport personnel that have shown an interest in air cargo either through membership of the ACI Air Cargo Committee or air cargo projects on their respective airports. Potential participants were emailed twice to ascertain whether they would attend or not.

Participation

The roundtable was moderated by Kitty Freidheim, President of Freidheim Consulting LLC and a member of the ACRP Study team. Participants included Tom Green, Senior Manager of Air Cargo Development and Operations at Seattle-Tacoma International Airport (Sea-Tac); Cece Poister, Manager of Air Cargo Development at Pittsburgh International Airport; and Rick Busch, Director of Planning at

Denver International Airport. Additionally, a separate meeting was held with Mary Davis, Director of Marketing at Tucson International Airport.

Discussion

The discussion focused on trends in the cargo industry which could ultimately impact the planning and design of cargo facilities. The trends which were identified included carrier consolidation of carriers and ground handlers, shifts in aircraft size, interest in perishable facilities, dominance of third-party operators, shorter leases, dominance of integrators, decline in mail traffic, and diversion to trucking.

Each airport represents a different profile in terms of location and size. Seattle-Tacoma International Airport is a large gateway/hub on the West Coast; Pittsburgh International Airport is a medium-sized, inland airport; and Denver International Airport is a medium-sized, mid-continental airport and hub to United Airlines. Their experiences with current trends vary due to the characteristics of their geographic location, market size and local economy.

Their respective cargo numbers in 2011 were: 279,624 metric tons for Sea-Tac; 79,793 metric tons for Pittsburgh; and, 248,141 metric tons for Denver.

GENERAL TRENDS

Pittsburgh identified aircraft size, which is having an impact on cargo, as an important trend. At this airport, medium-sized aircraft traditionally handled palletized cargo, but are now handling small packages and individual pieces. Pittsburgh has also experienced consolidation of individual airlines under single ground handlers. Lastly, it has experienced a significant change in the rules and regulations of screening for cargo.

Sea-Tac does not have aircraft gauge challenges. It has a reasonably active international business that is experiencing new routes operated by Emirates and ANA. This represents a fair amount of wide-belly aircraft for which they have adequate capacity. The airport has minimal domestic wide-belly aircraft activity as this gauge of aircraft has been retired from many domestic passenger fleets in the U.S. SEA exports more tonnage and value than it imports. Activity to Asia and Europe is trending upward with 2011 being Sea-Tac’s peak year for tonnage to Asia. Agriculture is Sea-Tac’s biggest sector for shipments, but it also has local and Alaskan seafood product as well as some technology shipments. There is very defined peaking from mid-June to mid-August, particularly with the export of cherries, produced in the Northwest, for which there is more cargo demand than capacity. One-third of this product goes north to Vancouver and one-third south to Portland and/or all the way to San Francisco, sometimes even to Los Angeles. As many as 133 wide-body cargo aircraft have transited through this airport in a single month during cherry season.

Sea-Tac’s stated that domestic all cargo freighter activity has declined. In its airport the only remaining domestic cargo carrier is Delta, which maintains a couple of routes.

Denver currently is dominated by domestic freight activity with international wide-body service only to London and Frankfurt. Its previous domestic cargo activity included a regional air network, which is now being handled by trucks. This is a result of domination by the integrators, such as FedEx and UPS, whose operations include air freight and ground trucks as well as the strategic regional location of Denver for the type of operation offered by the integrators.

AIRCRAFT SIZE AND PARKING SPACE REQUIREMENTS

Sea-Tac has experienced larger aircraft on multiple levels. Recently, its foreign cargo operators, such as Cargolux, have been flying in the B747-8, and it is expected that Korean Airlines will begin to do the same in the near term. Airport staff has also observed FedEx up-gauging. Sea-Tac no longer sees narrow-body FedEx aircraft but 300s, DC 10s, MD11s or B777s. It will continue to have ATR 42s, 72s and Cessnas operated by the integrators because their feeder system requires service to/from the islands off of Washington State as well as smaller markets to the east, such as Yakima and Spokane. Although there are available ground routes, truck deliveries are inefficient to these destinations.

Denver has a linear arrangement for aircraft parking on the cargo ramp, and if there is nose loading, aircraft are parked on a diagonal, but this is rare. The only time B747 cargo aircraft are on the airport is typically during the holiday rush. Most other times, they are only present about once per day. Denver will add a B777 route to Tokyo in the spring of 2013.

Denver occasionally handles an Antonov 124, and then parks it on a small de-icing pad, which provides enough room to get a loader out in front of the aircraft. These aircraft were present during the period when Lockheed Martin was building the Atlas missiles and the Russian airline had the contract to carry them to the Cape or the Vandenberg.

Pittsburgh has recently repainted its cargo parking lines to accommodate bigger aircraft. However, its total space is quite large, and the airport was able to accommodate an enormous number of aircraft during the international G20 meetings. A number of these aircraft were large wide-body aircraft.

FINANCING AND LEASING

Each of the three airport representatives indicated that their cargo buildings were either leased to third-party operators or airlines.

Pittsburgh reported that their cargo buildings are controlled on a long-term basis by AFCO. A long-term lease in Pittsburgh is considered to be 15 years. The ground is owned and controlled by the airport, and only the building is owned by the operator.

Pittsburgh reported that they also have a facility that is leased by Dick's Sporting Goods, which built their corporate headquarters on the airport. The facility has about one million square feet, and is all office space. It is located right on the airfield, and has its own corporate hangar, which holds about three jets. The rental fees are based on a typical property lease. Sea-Tac cargo facilities are controlled by third-party operators and carriers. These facilities were developed by a range of parties, such as AFCO (no longer present), ProLogis (formerly AMB), and TransPlex of British Columbia. They were developed in the `70s and `80s, and there did not appear to be any consistent policy at that time as to length of lease or options. The agreements were ground lease, operate, and transfer. They are now expiring, after which the building is returned to the airport. The end result is that that airport collects a series of buildings that are in very bad shape and in need of repair.

Sea-Tac is examining policies related to new leases. The airport has the choice of either releasing the building to a third-party, which would most likely continue the same pattern of management but would allow the airport to collect more revenue from the transaction, or the airport could take a more direct management role over the buildings. However, that is not a role the Properties staff has taken in the past, and property management issues can present challenges. The Properties Division is separate from the Cargo Division which makes it challenging to provide direction. Multiple issues related to financing and management of such buildings are being examined. The airport has commissioned consultants to assist it in assessing building conditions but is currently doing the financial analysis in-house.

Sea-Tac currently charges ground rent and more recently building rent. The rents are based on square footage, and the rent is not based on any kind of concession or profit.

Denver leases 99% of its cargo buildings to carriers. United operates cargo under its original lease, which included the maintenance base, Concourse B and some other facilities dating back to the original airport. Both FedEx and UPS have long-term leases, and BAX and DHL/Airborne are also in long-term leases. There are no third-party operators, and the airport does not have a percentage share of the revenue profits.

PERISHABLES

Sea-Tac reported that perishables are a huge part of its business. However, it does not have a consolidated facility, and perishables are handled in a variety of ways with different operators, ground handlers and carriers. Many of these tenants have some ability to keep items cold or frozen, if necessary. However, cherries, which represent a very large part of the perishable business, are cooled in the cleaning, packing and boxing process, which is accomplished with chilled water. They are cold enough at that point, and the delivery is very rapid. After they are palletized, the cherries are placed in cool-wrap, which is essentially foil, and then they are rushed to market. A cherry picked in Washington State could be in Taiwan within three days. Speed is utilized rather than refrigeration. However, the airport is seeing more competition from ocean shipping in an oxygen-less, chilled environment, and if those shippers can maintain the quality, they will be able to gain market share on air shipments.

Denver does not have a perishable facility, but will be addressing this opportunity in the Airport Cities effort. The major product shipped is beef, which is commonly transported to Asia.

Pittsburgh worked hard to bring a perishable flight from Colombia to its airport, as transit through Miami is challenging, particularly with U.S. Customs. Cece Poister identified trucking patterns from Miami along the East Coast and believes there is a lot of opportunity for perishable handling at other airports. Rick Busch commented that it is literally 48 to 72 hours from the time flowers are in the field until they reach New York.

Pittsburgh also reported perishable cargo, such as flowers, arrives in Miami, is cleared there and then trucked all the way up the East Coast. These are not direct runs to some major center at JFK, but multiple stops all along the way where drivers have keys to individual wholesalers where they make drops in the middle of the night. These haulers also bargain for return goods so they do not return with an empty truck.

MARKET GROWTH

Growth at Pittsburgh is represented by textiles and apparel from Vietnam manufacturers. Pittsburgh has a major retailer, American Eagle Outfitters, as well as Dick’s Sporting Goods. Much of their market production is slowly shifting to Vietnam for reasons related to labor costs and quality. While Southern Air had several test flights in 2010 there currently is no direct shipment from Vietnam, however.

Growth at Sea-Tac continues in the agricultural products, technology and seafood sectors.

Growth at Denver is in bio-medical shipments as there are some major research facilities in Denver. Computer technology (IT) activity has largely disappeared.

MAIL

Both Denver and Pittsburgh commented on the decrease in mail activity. Denver has dropped 50% of its mail activity since 2001, in part due to electronic mail and the United States Postal Service (USPS) relying more on trucking. Pittsburgh commented on conversations held with USPS representatives, who indicate that they simply do not have the mail volumes they used to carry.

In Denver a mail services handling program will take a forwarder directly to the bulk mailing site. The security for this is presumably handled at the Post Office facility like a trusted shipper. At Sea-Tac, Matheson (a USPS contractor) runs an airfield cross dock building at which the postal trucks show up on one side where it is containerized. It is then sent out and taken to the airside to be delivered to FedEx who transports it to their hubs for sorting and distribution.

INTEGRATORS

Sea-Tac indicated that FedEx's presence is huge at its airport and has 40% of the total market. Its 75,000 sq. ft. throughput building is on the airport but all of their logistics, ground operations and other functions are scattered around the area. FedEx operates on its own trend line and is independent of the other cargo operators. UPS, DHL and BAX operate at King County (BFI), which is a smaller airport that is also known as Boeing Field, located closer to the Central Business District. Both UPS and DHL discuss coming to Sea-Tac occasionally, but look for highly discounted rates.

Sea-Tac reported that it is fairly common for UPS to have small facilities on airport and to load directly onto trucks whereas FedEx cargo goes through its automated sort facility in its building before going into their trucks. Denver concurred with this experience and said that UPS does this from the aircraft side loading directly onto the trucks.

In Pittsburgh FedEx and UPS are the major players and are neck-and-neck with one another, but there is still room to grow. FedEx has one more aircraft per day than UPS, but this depends on the season and other factors. Cessna Caravans are used for feeder service to markets such as State College and some of the outlying areas. The integrators sign contracts with major retailers and are able to lower their rates due to the anticipated volume of shipments.

In Denver, the integrators have the overwhelming majority of the traffic. FedEx has more cargo than UPS, but combined, the two actually control 80% of all cargo. UPS has a major feeder operation with Navahos and Metroliners, which are used to distribute to smaller towns in Kansas, Colorado and Nebraska. FedEx takes a different approach and uses a B727 to Cheyenne and Colorado Springs, while UPS comes in by truck and small aircraft.

TRUCKING

All three airport representatives indicated that there is a lot of diversion to trucking which can provide a three-day valid and economic delivery.

Sea-Tac stated that a trucker who is time definite is competitive with air cargo and will get the business.

Pittsburgh reported that FedEx Ground is headquartered there and is growing exponentially.

Sea-Tax indicated that this pattern has caused some air cargo operators such as Kittyhawk to go out of business.

Pittsburgh reported that a small trend to watch in the trucking industry is the number of long-haul truck drivers who are ready to retire and a lack of qualified workers to replace them. Much of the workforce does not have an interest in being gone for a week at a time, and although the industry pays well, it is difficult to find candidates who pass the screening tests. Deliveries to airports require background scrutiny, and many in today's workforce do not have a clean record that is required to do the job.

Denver is a very convenient interior trucking location. The market at Denver has changed from overnight "must-get-there" to two to three "just-in-time" delivery days, which brings trucks into play, and they are just 1/10th the cost of flying. In 24 hours a shipment can get to the West Coast or Chicago or even to Dallas from Denver. However, for shipping overseas, it makes sense to go to the gateways.

FREIGHT FORWARDERS

Freight forwarders are responsible for making mode choices for their customers based on what shipment has to be at a particular destination at a particular time. If that date is not tomorrow, the shipment does not have to go by air. On a personal basis, the statement was made that if a product was needed so badly, the decision would be to ship by air but generally the preference for delivery does not require this kind of immediate delivery.

Sea-Tac stated that mode decisions are dependent on how supply chain logistics are set up. Generally, the timeline is predictable but occasionally, there may be a manufacturing problem which causes a delay in shipping. In that case, an air freighter will be chartered to solve delivery glitches for product that typically would have been ocean shipped.

The majority of freight forwarders are located off-airport. When transferring cargo to carriers they do not by-pass cargo buildings and go directly to the ramp but rather go directly to carrier warehouse truck docks. Sea-Tac only observes delivery activity on the ramp with Boeing's large equipment shipments which are escorted or badged. Through the fence operations are not allowed due to the competitive environment and because Sea-Tac does not have the facility to do that – it simply is not possible to allow flatbed semi-trailers to wander down to find the belly cargo passenger planes.

DATA

Sea-Tac asks the carriers to report air cargo tonnage in a few categories: enplaned, deplaned, international or domestic. For the first time, in the last couple of years the carriers have also been asked whether the cargo is freighter or belly. The reporting is entirely voluntary and no revenue is based on the data. The quality of the reporting is uneven, and when an anomaly is observed, further verification is requested.

Pittsburgh concurred with Sea-Tac.

Denver reported that the data is required under the leases, rates and charges that the carriers report on their landing fees. However, nothing is charged on a per ton basis, so it is reported as Sea-Tac described. It is broken out by freight versus mail, international versus domestic, and enplaned versus deplaned. Other than that, the carrier can report anything they care to, and Denver does not perform a cross-check.

CONSOLIDATION

Pittsburgh reported that their experience has been that most carriers have abandoned their individual cargo warehouse facilities and have consolidated under one ground handler. This trend applies to freight forwarders as well as airline carriers. For example, BAX is now part of Schenker. Eagle has gone. The number of cargo players has shrunk, and there are not as many ground handlers at the airport.

Sea-Tac said that it is experiencing vacancies but estimates that 50% is due to consolidation and the other 50% to mode shift. Internationals choose a consolidated ground handler but the main domestic carriers such as Delta, United, Southwest and Alaska all handle themselves as does Fed Ex.

TUCSON

A separate conversation was held with Mary Davis, Director of Marketing at Tucson International Airport.

Tucson has a cargo development plan which dates back to the early 2000s. Freight forwarders were part of the boom but they have all left in the last four to six years. Only FedEx remains and its competitor UPS is located off airport across the border in Nogales, Mexico.

As Tucson looks to economic recovery, it is focused on the trade relationship with the Mexico province Sonora where it is believed there is regional potential. Bonnie Allen, the Airport Director, is interested in pursuing this potential but currently there is no international activity, no cargo experts or other knowledgeable staff in the cargo area.

Tucson has 5,000 developable acres of airport property. The airport contributes $3.2 billion to the local economy and wants to leverage its potential. The airport has no data relating to cargo demand but when they examine the link between the Port of Tucson (a dry port) and Mexico, they intuitively believe such demand exists.

Ms. Davis is interested in developing a new plan to attract cargo business to Tucson.

APPENDIX E: TECHNICAL MEMORANDUM ON THE CASE STUDY AIRPORTS INVENTORY AND DATA COLLECTION

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ABSTRACT

This Tech Memo provides the findings from ACRP 03-24 case study airports inventory and field work findings. The memo first provides a summary for each airport visited (about 1 page each) then provides Inventory narrative on each of the 16 case study airports visited. During these visits team members interviewed airport planning and marketing staff and key air cargo businesses located on the airport. Interviewer's general impressions of interview results and airport planning related to air cargo are provided.

INTRODUCTION

The objectives of Task 3 are to collect data representative from a wide range of airports, identifying the type and size of facilities comprising the existing air cargo marketplace. This tech memo provides the findings of the case study airport inventory process (Sub Task 3.2). This data will be used as a basis for exploring new cargo planning metrics. Data was gathered from international gateway, major domestic, integrated carrier hubs, and small regional facilities, and includes an inventory of cargo facilities at these airports by type, size, and throughput. This tech memo provides individual narratives on each case study which are prepared by each team member assigned to the airport. While these narratives follow a general outline they provide individual team member perspectives on interview outcomes.

CASE STUDY AIRPORT FIELDWORK HIGHLIGHTS

The highlights of each case study airport are presented in alphabetical order by airport name in this section. Sixteen airports were included as case study airports and include:

- Austin Bergstrom International Airport (AUS)
- Cincinnati/Northern Kentucky International Airport (CVG)
- Dallas-Ft. Worth International Airport (DFW)
- Denver International Airport (DEN)
- Des Moines International Airport (DSM)
- Dulles International Airport (IAD)
- General Mitchell International Airport (MKE)
- Hartsfield-Jackson/Atlanta International Airport (ATL)
- Indianapolis International Airport (IND)
- Kansas City International Airport (MCI)
- King County International/Boeing Field (BFI)
- Louis Armstrong-New Orleans International Airport (MSY)
- Rickenbacker International Airport (LCK)
- San Antonio International Airport (SAT)
- Seattle-Tacoma International Airport (SEA)
- Spokane International Airport (GEG)

Austin Bergstrom International Airport (AUS): AUS is the second newest airport to have been built in the United States. Built on the foundation of the old Bergstrom Air Force base, the new airport provides a dual runway system, with the longest at over 12,000 ft., over 300,000 sq. ft. of new cargo space, with over one million sq. ft. of dedicated cargo aircraft parking. The airport is less than 10 miles from downtown Austin. Moreover, this new airport was located right in the middle of one of the fastest growing and most prosperous cities in the United States supporting high tech manufacturing and the corporate headquarters of the world's largest computer manufacturer, Dell computers. FedEx Express, UPS and DHL have stations on the airport with FedEx Express being the largest.

Cargo facilities at AUS are somewhat unique for a number of reasons. First, since this airport is relatively new, there was a chance to place the cargo facilities in a much more favorable location on the airport. As a result of good planning, there are two distinct cargo campus at AUS; a passenger airline belly cargo area, directly adjacent to the passenger terminal, and the north side cargo area on the northern tip of the airport, near the airport's its entrance. Both cargo areas share a common entrance, appropriately named "Cargo Road," and has a prominent position on the airport site.

A second unique attribute regarding the airport's cargo development is that the City of Austin chose to have 100% of their cargo facilities developed by third-party developers—one of the few completely privatized airport cargo sectors in the country. To make this point even more unique, three different developers built and operate the facilities to this day: Lynxs, Aeroterm and AFCO. Very few airports have such competition and the result is a wide range of options and congenial attention to the customers' requirements.

Finally, the City built cargo for the future. All facilities and ancillary infrastructure such as aircraft parking, taxiways, fueling, etc. are oversized. The other side of this coin, however, is that Austin is clearly overbuilt for the near term. Its existing infrastructure could probably handle 300,000-400,000 annual metric tons of cargo. AUS, however, maxed out at approximately a third of this capacity (150,000 MT) in the early 2000s, and then promptly dropped to one-sixth of this as of 2012.

Cincinnati/Northern Kentucky International Airport (CVG): ACI North America reported that year-over-year, total annual cargo tonnage at CVG grew from approximately 44,000 metric tons in 2008 to 115,000 metric tons 2009. Between 2009 and 2010 air cargo tonnage trebled from 115,000 to nearly 400,000 metric tons. This rapid growth is the result of DHL relocating their Wilmington Ohio hub back to CVG. Of the total cargo tonnage handled at CVG in 2011, DHL was responsible for the majority (92%), while FedEx (4%) and belly freight on passenger carriers (4%) made up the remainder.

CVG is unique in that is home to both a mega-cargo hub as well as several functionally obsolete cargo structures, many of which are to be razed in the coming years. There are eight cargo warehouse facilities on the airport grounds at CVG and one (FedEx Express Sort) off-airport in an industrial park two miles to the north. Kenton County Airport Board plans to demolish Terminals 1 and 2 in the next several years, which have an impact on air cargo operations, including relocating FedEx Express' on airport station. Overall the plan is to tear down these existing facilities in the near term. Many facilities both airside and landside were developed in the 1950s and 1960s and need replacing.

The airport's top priority is accommodating DHL and preserving the land at the south end of the airport for potential DHL expansion or development by DHL shipping customers. KCAB does not project major growth in air cargo demand outside of DHL, but intends on being flexible to other cargo uses through existing/modified/new structures. Attracting FedEx Express' sort operations back on airport with a single modernized facility is desirable for KCAB; however, no concrete plans exist. DL has a newer facility that is underutilized since their passenger hub activity has been decreased 80% of flights. Wide body flights to Europe have been reduced from four to one.

Dallas-Ft. Worth International Airport (DFW): While DFW has undergone air service and other macro trends similar to at least one other ACRP case study airport (ATL), none of the case studies offers more diversity of cargo facilities than does DFW. This fact depends not only upon the incomparable property development opportunities afforded by DFW's more than 17,000 acres but also by its development model choices. Unlike ATL where the airport operator has developed almost all of the on-airport cargo facilities, DFW has historically favored private development – either by third party real estate developers or by the tenants.

Like most U.S. airports, DFW has experienced a dramatic drop in annual cargo volumes – down 29% since its peak year (1999) and only 2.5% higher than twenty years earlier in 1991. Yet while most U.S. airports' cargo declines were driven by simple contraction of existing tenants and the demise of former tenants, DFW has undergone a more complex transition in the composition of its cargo carriers. Consequently, while domestic cargo has dropped precipitously, DFW's international cargo – particularly that transported on all-cargo flights – has risen but insufficient to neutralize domestic losses. Since 2000, DFW has lost a U.S. domestic passenger hub for Delta Airlines and a headquarters for defunct former all-cargo carrier Kitty Hawk.

The net effect has been to create vacancies and chronic underutilization in facilities – such as the former Kitty Hawk hangar and headquarters buildings, the mostly abandoned Delta Airlines cargo complex and much of the American Airlines' freight complex – poorly suited to the needs of freighter operators. Since the peak year of 1999, DFW's remaining major integrated carriers have suffered relative stagnancy (FedEx down 13%) and worse (UPS, down about 28%).

DFW has experienced growth in international all-cargo operations for which it has developed a series of suitable on-ramp facilities. Because none of these carriers offers DFW-exclusive flights but rather triangulates DFW into multi-city routings, DFW may grow its tonnage simply by having carriers dedicate more of the aircraft to the market without necessarily increasing frequencies and thereby impacting ramp capacity. DFW's roster of third party cargo handlers expressed confidence that additional manpower would be more immediately required than additional warehouse space should new or expanded operations be introduced.

All cargo facilities in the international area were built by ProLogis who is studying whether to expand although it is down overall in cargo traffic due to integrators and belly passenger traffic of DL and AA. International all cargo traffic has increased dramatically to the point that NCA and Asiana will start operating at the DFW in late 2012. Although the growth in this area is significant DFW management does not want to get into the facility development side of the business but will leave that up to third party developers.

Denver International Airport (DEN): Between its peak year (2000) and 2011 (inclusive), Denver International Airport experienced a 47% decrease in annual air cargo with mail having fallen by 90% while freight (including express) fell by 24%. This decline came after airport management and its constituents had anticipated that the opening of a new international airport in 1995 would usher in extraordinary growth. DEN ended 2011 as the #5 airport in North America in total passengers which far exceeds its #24 ranking in total cargo. International gateway growth has languished as hub carrier United fortified its Chicago O'Hare gateway instead and no international freighter operators have entered the market.

Given that they dominated the mail sector that fell so dramatically, it is unsurprising that belly cargo carriers' total cargo tonnages at DEN fell by 72%. Belly cargo carriers' share of DEN cargo fell from almost equal to that of all-cargo carriers in 1996 to only 23% in 2011. United suffered an almost identical 73% drop in annual cargo and Frontier a similar 67% decline. Entering the market during the last decade, Southwest Airlines has grown into DEN's second-largest belly carrier with almost 5% of total cargo, trailing United's 10.4% but more than doubling Lufthansa's 2.3% and British Airways' 2.0%. International cargo was limited to belly carriers accounting for about 11,000 tons in 2011.

DEN's all-cargo carriers contracted greatly in diversity due to the same factors as other U.S. airports. While FedEx and UPS have long been DEN's leading cargo carriers, as late as 2001 other all-cargo carriers accounted for about 19% of the airport's total cargo. In 2011, FedEx had 44.7% and UPS had 25.8% for a combined market share exceeding 70%, up from about 42% in 2001. While FedEx's tonnage has fallen 18% since 2001, UPS's grew by 28% during the same period. In addition to its own aircraft operations, UPS supplements its regional operation with small feeders operated by Key Lime Air.

Given a 47% decrease in annual cargo tonnage, DEN's need for additional cargo capacity is so lacking that the highly touted World Port development has already been repurposed to house a rental car company and file storage, among other uses. All on- ramp cargo facilities are managed by the airport, rather than 3rd party developers. By conventional measures, the cargo facilities are mostly underutilized and yet the only multi-tenant facility has a large number of belly cargo tenants and two handlers. These carriers require only GSE space rather than aircraft parking ramp. Additional capacity could be found at the DHL terminal shared with DHL's handler Integrated Airline Services (IAS) which has ramp and therefore could potentially accommodate other freighter operators. However, Transpacific freighter operators increasingly will use B747-800 aircraft. The last decade of results and a dearth of interest from freighter operators provide a poor platform for costly improvements with such limited demand.

Market leader FedEx's significant decline in local tonnage, the more likely near to mid- term need at DEN may come from UPS which has increased its DEN tonnage by 28% while hosting its Supply Chain Solutions operation off-airport and maintaining the Key Lime Air feeder operation at a remote ramp. In terms of planning, any expansion or other improvement would specifically not be speculative in nature but rather would be undertaken at the direction of UPS, if not actually by UPS.

Des Moines International Airport (DSM): For much of the 1980s and 90s, DSM's air cargo growth was fueled by the growth of UPS's 2nd day air hub but as deferred- delivery shipments increasingly were diverted to pure truck transport, the local UPS operation was marginalized and along with it, DSM's cargo operations dwindled. Cargo still outperforms passenger activities in terms of DSM's ranking among U.S. airports but has slipped as a local priority. In the past, local optimism about cargo growth fueled aggressive capital investing in cargo-specific improvements, specifically the almost 1.6 million SF cargo aircraft parking ramp. DSM's cargo warehouse construction (listed as 93,600 SF in the latest master plan) was more modestly tied to specific needs of existing tenants. The master plan (published in September 2007) and articles coinciding with individual expansions convey that DSM's periodic cargo growth and stagnation were often tied to capacity issues. While capacity can become a limiting factor, cargo carriers (especially UPS) are adept at working in far less than optimal conditions. Much of what has driven DSM's former cargo growth and recent declines have been network developments little affected by local conditions.

For the foreseeable future, this leaves DSM with relatively few prospects to backfill cargo facilities vacancies but the airport may still find itself in cargo facilities development mode. Depending on near-term growth expectations for passenger operations, the airport authority may replace its current terminal and at least one development option would cause the relocation of the airport's cargo tenants. Otherwise, DSM is more likely to face redevelopment than to require new cargo facilities.

To cite only one specific example, the 2007 Master Plan's recommended forecast projected annual cargo tons to have grown to 125,191 MT's by 2011. Actual annual total cargo for 2011 was 61,584 MT's. Consequently, what the master plan had projected as a capacity shortage – based on actual capacity of 93,600 SF of cargo operating warehouse – would more likely suggest a capacity surplus. UPS has already begun consolidating its on-airport facilities in favor of its off-airport capacity and FedEx has room to grow in the building it currently occupies. Together, these two carriers account for more than 99% of DSM's annual cargo.

Dulles International Airport (IAD): Similar to other U.S. airports, IAD has experienced a dramatic drop in annual cargo volumes – down more than 21% since 2000. While domestic cargo has dropped precipitously, IAD's international cargo has risen but insufficient to neutralize domestic losses. IAD continues to host United Airlines with a hub operation providing a robust level of cargo activity. Many additional national and low-fare carriers continue to add passenger flights which have belly space for cargo. Foreign carriers continue to add flights to IAD as well, making room for cargo to additional destinations.

Dulles' air cargo facilities are primarily four relatively large cargo buildings totaling about 500,000 sf. of space. Two are 30 to 40 years in age the other two are much newer. All of the cargo is carried through belly cargo on passenger airlines with the exception of FX, UPS, and DHL. MWAA is seeking to attract all cargo carriers with transoceanic international routes but has yet to do so.

The cargo operation at IAD has been described as one with great potential. With limited perishable storage and no all-cargo carriers, IAD has limited physical and operational capabilities today. Significant plans for the future, however, intend to change that perspective. The Airport has more developable land that most Airports in the country and a rapidly growing industrial development and import/export market in DC and Northern Virginia. The Airport's relatively high cargo space occupancy rate and increasing interest in surrounding warehouse development is a testament that future cargo expansion at IAD is inevitable.

400-acres on the west side of the airport are earmarked for air cargo expansion to double their cargo capacity. At the price they will be asking there will likely not be much demand for these facilities. Additionally, Loudon County is promoting about 500 acres off airport for cargo development. MWAA and the county will be competing with each other for cargo tenants. Off airport expansion will likely be pursued by cargo carriers to keep their costs down.

General Mitchell International Airport (MKE): General Mitchell International Airport in Milwaukee, Wisconsin has, for the past decade, concentrated on becoming "Chicago's Third Airport" and has continued to grow its passenger traffic by providing the growing number of residents in the northern part of the Chicago metropolitan area as a convenient, less-congested alternative to Chicago O'Hare International. However, this success at developing passenger traffic has not translated into growth in cargo shipments. Most of the increase in passenger flights occurred on regional jets, so the airline's cargo capacity did not expand proportionately. At the same time, local overnight letters and packages that had been shipped by air on FedEx were directed to new FedEx ground service, thereby blunting growth in air cargo shipments. One of the chief cargo development issues at the airport is MKE's proximity of Chicago O'Hare. It is quite common for air forwarders truck to O'Hare with its abundance of air cargo lift. Southwest Airlines commonly trucks cargo to Midway the nearest focus city, or hub, in the carrier's network which provides significant belly lift capacity.

Today, FX and UPS are the dominant air cargo carriers at MKE with approximately 98% of activity. Resultantly, MKE has quite a few cargo feeder airlines supporting FX and UPS ops with flights into smaller Wisconsin markets. Finally, the 2008–2009 recession negatively impacted cargo traffic across the country, and MKE's shipments dropped accordingly. The MKE's 2008 master plan did include a site to the west of the current MKE-owned cargo building for possible cargo facility expansion but did not estimate a timetable for its implementation. Although admitting the difficulty of projecting future air cargo shipments, the master plan projected future growth in cargo traffic. Projections for 2011 cargo shipments were 30% greater than actual shipments. With excess cargo facility capacity and limited prospects for growth, MKE appears to be focusing heavily on developing its passenger traffic and leaving cargo traffic development up to the shippers.

Hartsfield-Jackson/Atlanta International Airport (ATL): Hartsfield-Jackson Atlanta International Airport (ATL) ranked #10 among all U.S. airports in total cargo. ATL experienced a 23% decrease in total cargo since 2000, falling more than 200,000 annual tons (MTs) to a 2011 total of 663,162. International cargo rose rapidly (44%) during the period but was inadequate to compensate for a 54% drop in domestic cargo from what had been a much larger base. ATL's international cargo first exceeded domestic cargo in 2006 and increased that margin in 2011 to 59% international. Domestic mail fell more than 90% between CY 2000 and 2011 (inclusive), collapsing its share of ATL total cargo from almost 25% in 2000 to only 3% in 2011. This loss most impacted belly carriers. Domestic freight fell by just over 33%. International mail grew but only from a very small base, from 1,122 MTs in 2000 to 4,953 MTs in 2011. International freight grew by 58%, a gain of more than 100,000 MTs over ATL's CY 2000 annual total to a 2011 total of 385,178 MTs.

In 2011, Delta was ATL's market share leader in both total (34%) and international (35%) freight, trailing only FedEx in domestic freight (32%). As occurred with ATL cargo generally, Delta had contrasting experiences with its domestic tonnage decreasing 39% between 2000 and 2011, even as its international tonnage grew 33%. Compared with its peak year of 2004, Delta's 2011 total freight was down 31%.

Among domestic all-cargo carriers, FedEx ended 2011 with almost the same tonnage as in 2000 but grew its share from 28% to 43% on the basis of a shrinking market. The same applied to UPS' market share expansion from 10% to 16%. All other carriers that once comprised ATL's domestic all-cargo tenants, as well as other domestic belly cargo carriers lost heavily from past peaks.

ATL's international market share has significant representation from no less than fourteen carriers besides hub carrier Delta, including many that initiated ATL operations during the decade. None rival Delta but Korean Air leads the remainder with 11% of the ATL international freight market, followed by EVA Airways (9%), Lufthansa (8%), British Airways (6%), China Airlines (6%), Asiana (4%), Cargolux (4%) and Cathay Pacific (4%). International cargo grew predominantly on the basis of freighters requiring dedicated ramp positions, causing the airport to develop a separate international complex on the airport's south side. Apart from Delta, all other international belly cargo would be more effectively handled in this complex given the intersection of common third party cargo handlers, bonded facilities, regulatory inspections and common carrier trucking and couriers already serving the international freighter operators.

The complex has three 130,000 SF buildings (100,000 SF of warehouse and 30,000 SF of office) all with contiguous ramp capable of supporting 747-8 freighters. All were developed by the airport and master-leased to third party handlers, except for half of one building leased to Lufthansa. The other half of that building is leased to Swissport, which also leases 100% of another building. The third building is leased to Alliance Ground International (AGI). The non-Delta 2011 balance of international cargo totaled about 244,000 MTs, handled in 300,000 SF of cargo warehouse. The existing international facilities are 100% leased and according to handlers, 100% utilized at peak periods and about 80% utilized under normal conditions. An existing location for another 130,000 SF module already exists next to the Swissport-occupied building, which will complete two symmetrical segments of two buildings each. The airport has indicated it will invite private developers to participate in the new facility expansion.

Indianapolis International Airport (IND): IND has two successful air cargo strategies. FedEx Express operates its second largest North America hub on the airport and CargoLux operates international cargo routes to and from Europe with the majority of the commodities carried being pharmaceutical products. Pharmaceuticals have proven to be a niche market for IND that justifies three flights per week. IND is striving to be an alternative to Chicago's O'Hare for international air cargo shipments, but faces the same issues as other small-market airports; there has to be enough tonnage going in both directions to justify scheduled flights. O'Hare's extensive schedule of international and domestic flights, its massive air cargo support infrastructure, and its capacity for growth will likely limit the amount of cargo that can be captured by IND.

FedEx accounted for 98.7% of IND cargo shipments in 2011. All other all-cargo carriers captured a 0.89% share, leaving only 0.41% carried in the bellies of passenger aircraft. Working with freight forwarder DB Schenker and Cargolux, IND has recently added a third weekly cargo flight to Europe. The airport also sees several ad hoc wide-body air cargo charter operations related to the transport of IndyCar Series racecars to tracks around the U.S. and the world. IND has the capacity to meet all its cargo needs for the near future and has no immediate plans for developing additional cargo facilities.

As part of the redesign and development of its facilities, IND recently constructed a new 40,000-square-foot state-of-the-art building called the Airline Services Support Building. The building opened on September 1, 2010, at 7899 South Service Road. Tenants include: American Airlines Cargo, JetPro, GSRX, Skytanking, Global, Quantem Aviation Services, and Southwest Airlines. The building's users noted some design flaws, including short turning radii at the truck docks and inconveniently placed internal support columns that have detracted from the overall efficiency expected in a new facility with ample land for development.

Kansas City International Airport (MCI): MCI has experienced a drop of 47% in annual cargo tons since MCI's peak year (1999) has left the airport with a surplus of on- ramp cargo facilities. Occupancy rates at MCI's three on-ramp multi-tenant facilities ranging from 60 to 70% would be worse if not for the presence of non-cargo tenants.

The only single-tenant on-ramp facility at MCI is that occupied by FedEx Express which is MCI's market share leader with roughly 64% of total annual cargo. Even with that dominant share, FedEx only tallied 0.62 tons/sq. ft. in its 89,000 sq. ft. facility. FedEx's CY 2011 annual cargo tonnage at MCI was 14% lower than it handled in the same facilities in CY 2004.

All of the other cargo carriers at MCI combined for only a 36% market share – roughly 31,000 tons in CY 2011. Of that total, 21,000 tons were carried by UPS and 9,700 tons by all other carriers combined. All of these carriers – some by third party handlers – are accommodated in MCI's three multi-tenant on-ramp facilities. These three on-ramp facilities have a combined 0.17 tons/sq. ft. based on CY 2011 tonnage. Ramp utilization at the three multi-tenant facilities is at least as dismal. While multiple turns on single aircraft parking positions are common at gateways, positions go unused for days at MCI.

The outlook for growth at MCI is mostly discouraging. The two dominant carriers at MCI – FedEx and UPS with a combined 89% market share of CY 2011 tonnage – mirrored their national strategies with significant investments in off-airport truck- oriented expansions even as their air cargo tonnage fell at MCI. With U.S. domestic growth projected to be relatively low for the next twenty years, MCI is not likely to require new on-ramp air cargo capacity for the near to medium-term planning horizons.

Conversely, MCI has hosted growth from a Forward Air trucking terminal that first opened with 30,000 sq. ft. in 2002, then augmented in two increments to its current 80,000 sq. ft. This facility is not on-ramp but faces the on-ramp facilities on the same dedicated roadway serving all of the cargo facilities. Under more constrained conditions, this facility would have been a candidate for off-airport development but MCI has thousands of acres of developable land and has selected Trammell Crow Company as master developer for 640 acres of airport property. MCI Airport has little interest in cargo development now which is a paradox since it only a few years ago signed a master development contract with Trammel Crow for a logistics park on airport property for a traditional rail and trucking hub. TC has yet to break ground there. KC has one large building about 20 % occupied, MCI is likely to be candidates to tear down a legacy carrier building or two.

King County International/Boeing Field (BFI): BFI was included in the case study airports since our understanding of the Seattle air cargo market would be incomplete if we focused solely on Sea-Tac and not include BFI. There are two primary air cargo areas on the airport. UPS and DHL operate cargo jet aircraft on a scheduled basis at the airport and utilize the airports assigned "gates" or hard stands for these operations. Each carrier relies on feeder aircraft, primarily contracted turbo prop aircraft.

UPS is the largest tenant at BFI and carries the greatest amount of air cargo. The carrier operates out of a World War II era hangar and is a sub tenant to Ameriflight. Half of the hangar space is leased to UPS as well as a two story office wing off the hangar. UPS utilizes the hangar space primarily for GSE maintenance and storage. Nearly all of their package sortation takes place outside in an MDU facility which provides a conveyor belt in a covered shed. ULDs and trucks are loaded and unloaded at this facility. The airport will likely raze the hangar facility when the lease is up in 18 months, as a result, airport management does not know yet how Ameriflight and UPS will respond to this facility loss.

DHL operates an off-airport cargo sort facility approximately 4 miles north of the airport in addition to having an on-airport facility. DHL management indicated in an interview that while they could technically operate at BFI without a cargo building airport management insisted that they lease a building on the airport that is assigned with DHL's aircraft gates. DHL utilizes two hard stands for its two jet aircraft. One jet, a charter B676 aircraft operated by Capital Air Cargo, is assigned to DHL's west coast network while the other ABX B767-200 flies east to the

DHL hub at CVG.

BFI airport is owned by King County, and is administrated by the Airports Division. King County has sustainability goals and has developed the 2010 King County Energy Plan (Energy Plan) which provides a detailed roadmap to achieve goals and objectives outlined in the 2010 King County Strategic Plan. BFI has taken steps to comply with the Energy Plan.

Louis Armstrong-New Orleans International Airport (MSY): Between its peak year (1999) and 2011 (inclusive), New Orleans International Airport experienced a 45% decrease in annual air cargo to less than 50,000 annual MT's. Hurricane Katrina in 2005 had the temporary effect of diverting some all-cargo operations to Baton Rouge but this pattern ended by 2008. BTR now has negligible air cargo activity and MSY's post-recovery demand found its "new normal," reduced more by industry responses to recession than a natural disaster. The more enduring effect of Hurricane Katrina on MSY may be its damage to several cargo facilities that once would have been replaced but may no longer be needed.

As late as the 1990s, New Orleans still hoped to develop MSY as an air version of its major international seaport but the mix of Central American and Mexican carriers that have served the airport were gone years before Hurricane Katrina. Like so many medium-sized U.S. airports, MSY has become much more of a domestic integrator- dominated airport with the combined market share of FedEx and UPS rising from 65% in 2003 to 87% in 2011. Underscoring how demand has receded, even as the two carriers greatly increased their market share, annual tonnage fell by 18% for FedEx and 27% for UPS during the period.

Belly cargo fell from 21% in 2003 to only 13% in 2011. Dependence on narrow body passenger aircraft and the demise of international capacity has caused several freight forwarders and customs brokers to move facilities off-airport since their international focus is much more on trucking to other gateways. MSY belly carriers are led by Southwest with 6%, followed by Continental/United with 4% and Delta with 2%. These were the only three MSY belly carriers with more than 1,000 tons of cargo reported in 2011, while all other belly carriers combined for only 319 annual tons.

MSY has a mix of single and multi-tenant cargo buildings offering much surplus capacity for recent and current demand but reflecting MSY's former role as an international gateway. Apart from the FedEx dedicated facility, all of the cargo buildings with AOA access (either on-ramp or immediate tug-access) are managed by private developer Aeroterm, while several non-AOA cargo buildings owned by the New Orleans Aviation Board with a property management arrangement with Resources of Eight, LLC.

With a 72% market share, FedEx is MSY's dominant cargo carrier and somewhat fittingly has the newest cargo facilities (completed in 1998). Particularly for an integrator, FedEx's utilization rate of 0.64 tons/SF reflects enough capacity for growth that unless expansion of the passenger terminal compromises the FedEx facility, MSY's dominant cargo carrier should be adequately addressed. As with UPS, FedEx's ramp needs are modest given the aircraft required to accommodate its MSY volume and to serve the route between MSY and MEM (or SDF in UPS's case).

UPS has its Express and SCS operations in two different buildings at MSY. Given that UPS often has SCS located off-airport, the separation has not been a problem but UPS uses SCS space for Express when overflow requires. Putting the two UPS operations under a single roof (albeit divided to suit the distinctive operations) seems plausible but not essential. Similar to

FedEx, UPS had a 0.64 ton/SF utilization for its dedicated warehouse in 2011, suggesting surplus capacity for the foreseeable future.

With entire buildings – such as a 14,000 SF building formerly occupied by BAX Global/DB Schenker – now available and with all other carriers combined having accounted for only 6,236 tons of cargo in 2011, MSY's near term judgments more likely pertain to reuse/demolition decisions than expansion/improvement.

Rickenbacker International Airport (LCK): Rickenbacker supports a wide range of aviation, rail, and trucking activities. The airport occupies the center of the Rickenbacker Inland Port, which also includes the Norfolk Southern Intermodal Terminal, Foreign-Trade Zone No. 138, and the Rickenbacker Global Logistics Park. The airport provides two 12,000-foot-long runways that can accommodate just about any plane including wide-body freighters bound for overseas destinations in Europe and Asia.

The most significant air cargo activity at LCK is international cargo charter aircraft arriving from Asia. Kalitta Air LLC currently operates B-747 freighters to LCK from Asia two to three times per week. Although the frequency of these operations is consistent, these flights are not scheduled routes but are charters.

Both UPS and FedEx Express operate at the airport. DHL does not have aircraft operations at the airport but does have a presence in the Rickenbacker Global Logistics Park. FedEx operates an on-airport "over flow" hub and AirNet Systems maintains its world headquarters at the airport.

There are eight cargo warehouse facilities on the airport grounds at LCK:

- Four multi-tenant cargo warehouses two of which have access to the ramp
- One UPS cargo sortation facility
- One Forward Air sortation facility
- Two FedEx cargo warehouses and sortation facility
- One AirNet cargo sortation and HQ facility

FedEx warehouses on the airport from a third party developer Aeroterm. Federal Express purchased facility when they purchased Flying Tigers in the late 1980s. Later, FedEx sold it to AFCO who then later sold it to Aeroterm. Although the facility is not technically a regional hub for FX it acts as an overflow hub for their Global Superhub in MEM and their largest regional hub at IND.

UPS utilizes a 20,800 SF (160 ft. x 130 ft.), World War II era hangar facility located on the south side of the civilian area of the airfield. The facility has 628,000 SF of aircraft parking apron for sorting its inbound and outbound cargo. The facility has two truck doors but no truck docks. For staging cargo containers there is a docking "island" in the landside parking area. ULDs are off loaded at the docking island from 53' trailers then are transferred directly to aircraft on dollies, bypassing the cargo building. About 50% of cargo loaded onto aircraft arrives loaded in ULDs from other stations in the market.

One of the more unique cargo buildings on the airport is ACT4 a multi-tenant cargo facility comprised of approximately 48,000 SF, with 14 truck docks on the landside and 12 truck doors airside. This building is designed to support both air and trucking activity since the facility has direct access to the airside ramp. The building was constructed using a Federal AIP grant to fund 90% of construction costs. The facility was built on "speculation" in 2006 but currently has no tenants. CRAA owns the facility which is a "shell" which can be configured to any tenants design needs. The facility also has no center columns which allow unlimited cross docking capability.

San Antonio International Airport (SAT): Cargo traffic is starting to come back over last two years after a decade of declining cargo traffic (50% drop). At SAT the local cargo market "collapsed" 8 to 10 years ago but has never come back to previous levels. Cargo at SAT operates out of two distinctly different campuses: the City-owned belly- cargo facility on the eastern side of the airport, and combination city/3rd party owned all-cargo facilities on the western side.

A series of four buildings are used for all-cargo operations and an adjacent aircraft parking ramp stretch out along Wetmore Road representing the eastern boundary of SAT. The two oldest buildings are on the southern end of this complex and DHL occupies 15,000 sq. ft. in a stand-alone building originally built for Airborne Express. In contrast, FedEx Express is located in a larger facility totaling approximately 25,000 sq. ft. FedEx' sorting operation takes place in the warehouse for approximately 85,000 MT/year, representing the 53% cargo market share. This warehouse-to-throughput ratio represents either one of the most crowded integrator facilities on airport in the United States, or one of the most efficient because normally integrators do not attempt to shove this much cargo through such a small amount of space. However, cargo handling has gotten much more efficient, and San Antonio has the climate which allows more to be done out-of-doors, on the ramp. On the opposite end of this same area of the airport is UPS. UPS represents approximately 41% of the cargo market share at SAT. UPS operations spills out onto the aircraft parking ramp, and most of their actual operations are unabashedly outdoors, on and around the ramp. UPS maintains a relatively small building of less than 10,000 sq. ft., surrounded by outdoor sorting systems and racking for containers. Like most airports in the United States, belly cargo represents a small and shrinking share of the cargo market; in SAT's case, less than 5%. Nevertheless, SAT's city-owned 25,000 sq. ft. belly cargo building provides adequate airside access to the passenger terminal operations due to its location just to the northwest of the terminals. Wholly modern and adequate during its heyday in the 1950s and 1960s, the facilities are no longer efficient or well maintained. Moreover, these facilities appear to have three other major deficits:

- Landside access and visibility are extremely difficult. Put simply they are hard to find, and hard to get to even if you know where you need to go.
- Airside access is similarly difficult despite the good proximity to the terminals due to redundant security check points.
- They are in the path of growth of one of SAT's most prominent industries, aircraft maintenance and refurbishments. One only needs to look at the aerial of the surrounding buildings to note that the belly cargo facility is located in a sea of aircraft hangars.

Seattle-Tacoma International Airport (SEA): Sea-Tac Airport ranks 21st in air cargo volume in North America (2011) and is the third largest airport for international cargo on the West Coast (excludes Alaska). The airport offers daily, non-stop service to 77 domestic and 17 international destinations. Eleven of the international destinations are serviced with all-cargo main deck or wide-body carrier services. The Airport has approximately 680,000 square feet of leasable space in 15 airside buildings and more than three million square feet of aircraft ramp space.

Sea-Tac is short on cargo ramp space primarily due to the fact the airport lacks land capacity. The taxi lane between Buildings #2 and #3 and #7 does not meet the width recommended by the FAA for taxiing B747-8 aircraft when FX parks a B-777 aircraft on their ramp and while two B747-400 aircraft are parked nose in toward Building #3. Non- cargo facilities located within the air cargo side of the airport include: Port of Seattle Airport Maintenance, SWA provisioning, GSE repair station (southside Building #19), UA maintenance. The issue is there is limited land available on airport and off airport to relocate these facilities.

By 2020, the airport will own nearly all cargo buildings on the airport. While this increases revenue streams it will also mean the airport will inherit buildings that will require significant outlays for maintenance and improvements.

Building 18, the former USPS Air Mail Center was razed in 2012 to make room for a 400,000 sf passenger aircraft overnight parking ramp. This facility is a Remain Overnight, or RON, facility and will be constructed to taxiway grade in the next year. Given the airport's west coast location there is a higher propensity for aircraft remaining overnight. This facility will take parking congestion away from the passenger gates and is also the result of the airport's lack of developable land. This ramp may provide cargo aircraft parking on a space available basis but passenger aircraft will be given priority.

Eva, Alaska Airlines and Korean operate both cargo only freighters and passenger airlines. Alaska airlines is the only carrier at Sea-Tac operating combi-aircraft which have both passengers and air cargo ULDs on the main deck of the aircraft.

Spokane International Airport (GEG): GEG is a small commercial service airport with FX and UPS comprising about 97% of air cargo in market area. According to SIA, in 2011, 54,129.6 tons of freight and mail were handled at the airport with 58% outbound and 42% inbound. On the east side of the airport is their cargo ramp with expansion plans including several new rectangular-shaped air cargo buildings. But the issue comes down to what FedEx Express and UPS really want in terms of facility development. FX has the largest facility while UPS is the antithesis with a minimal pass through building and most activity taking place on the ramp since they use off airport cargo building.

There are three cargo warehouse facilities at SIA as shown on the subsequent page which is taken from an Administrative Draft of the Airport Master Plan:

- A multi-tenant airline cargo warehouse.
- A UPS cargo sortation facility.
- Two FedEx cargo warehouses and sortation facility.

UPS operates a second day deferred cargo hub at the airport only utilizes a 900 SF (15 ft. x 60 ft.) facility located south of its administrative facility on a 105,000 SF aircraft parking apron for sorting its inbound and outbound cargo. The facility has 18 dock doors for staging cargo containers, with 8 on each side, and 2 doors on each end. Inside the sortation facility, UPS has a five foot wide conveyor belt that runs down the middle of the facility which is used for sorting packages and cargo.

UPS has 4 arrivals and departures per day; two simultaneous arrivals in the morning and two in the evening. UPS's operates A300-622R, B767-300 and B757 aircraft. Two are parked side by side for each turn around operation. The aircraft are tightly parked with only 25 ft. of clearance between them, and the aircraft and the lease line.

In 2011, 65% of its total tonnage was tail-to-tail transfers, and 28% of its total tonnage bypasses its cargo warehouse and sortation facility and is trucked or tugged directly to the aircraft. UPS' peak hour tonnage is 77.9 tons, and they process 31,408 packages during the peak hour. While the current UPS facility appears to be adequate for their operation, UPS tonnage grew by 62.9% 2011 over 2010, and if that growth is sustained, it is questionable whether the current facilities will be adequate in the near future.

Team members visiting the airport noted that there is a huge difference between GEG and a large international airport. FX and UPS determine their facility size and lease the land from the airport. These integrators dictate their needs to the airport while the large international airports provide space on a take it or leave it basis. Airport management has little say on what goes into an air cargo building, since it is the carrier that determines the sortation and processing equipment. Airports often just provide land at the smaller airports. Airport management indicated that the community is growing and the community economic development leaders believe cargo is vital their long term growth.

GENERAL IMPRESSIONS BY THE CDM SMITH POST FIELD WORK AND PLANNER INTERVIEWS

Impressions on air cargo planning at airport organization level

- Air Cargo planning has "hands-off-approach" at many case study airports, particularly those with third party developers.
- Many midsized commercial airports perceive they are not in the cargo business.
- Airports – particularly international gateways – need to serve the cargo community and allow for land and space for cargo carriers and integrators expansion.
- Market appears to be shifting toward land lease programs and third party developers.
- Airports are finding a way to lease land or if they take a title back to a building they will lease it for a new revenue stream. So it is really a real estate play to them more than it is an air cargo issue.
- Apart from international gateways, more critical issue is how to manage surplus existing cargo capacity rather than expansion.
- At international gateways, annual tonnages have been fluid but carrier market shares – with direct implications for facilities – have changed even more dramatically. Belly cargo facilities (often lacking ramp) may exceed need for the long-term planning horizon while critical ramp issues have arisen as international freighters have expanded share.

Impressions on air cargo planning at cargo carrier level

- Survey fatigue was quite high at many airports visited.
- At the local level, within the air cargo carriers, there was no thought or strategy as to what cargo businesses were doing internally related to facility planning. There was an overall lack of networking between what managers were doing at the station level and at the system level.

Impressions on air cargo planning directions

- Providing land for just cargo facilities is something that airport planners should take to heart.
- Cargo facilities needed may not be traditional on-ramp multi-tenant facilities but rather off-ramp facilities accommodating more of an emphasis on truck-to-truck transfers.
- In markets in which non-integrated market share has fallen well under 10% even as FedEx and UPS have moved into their own facilities, airports must consider alternative uses or even demolition of legacy cargo facilities to make optimal use of land.
- Airport planning should coordinate with real estate, marketing and other airport management divisions to determine compatibility of traditional policy practices with the current environment. Rent escalators in decade(s)-old contracts with developers may cause on-airport facilities to go vacant rather than compete with off-airport real estate. Value of on-airport cargo facilities may be exaggerated in the more truck-oriented industry that now exists
- The anemic North American growth rates will be what most airports can expect over the next 20 years and as a result many airports in the future will be less inclined to develop air cargo facilities.
- FX has announced they are cutting $1.7 Billion from FX Express operations network, so we may see FX moving off some airports in the next two years. A competitive response from UPS is certainly likely, although possibly less dramatic in terms of on-airport facilities demand simply because UPS has traditionally had more of an off-airport warehouse concentration.
- Domestic O&D traffic growth will likely be a repeat of the anemic North American growth rates of the recent past but the international growth will look more favorable. Consequently, stark contrasts are likely to arise between the relatively few airports serving as international gateways and the vast majority for which decades may be required to return to past peak volumes.

INTRODUCTION TO INTERVIEW RESULTS

This tech memo provides individual narratives on each case study which are prepared by each team member assigned to the airport. While these narratives follow a general outline they provide individual team member perspectives on interview outcomes. **Table A-1** below provides the list of organizations interviewed at each case study airport.

Table A-1 Interviews Conducted

Interviews Conducted				
Airport	**Staff**	**Lead**	**Participants**	**No. of Attendees**
Austin Bergstrom International Airport (AUS)				
AUS	Maynard/Brimble	CDM	Airport Planning	3
			Lynxs Group	1
			DHL Station	1
			FedEx Station	2
Cincinnati/Northern Kentucky				
CVG	Maynard	CDM	Airport Planning	3
			Delta Airlines	1
			DHL Airport	1

Interviews Conducted				
Airport	**Staff**	**Lead**	**Participants**	**No. of Attendees**
			Kuehne and Nagle	1
Dallas-Ft. Worth International Airport				
DFW	Webber	WAC	DFW Planning,	9
			ProLogis	2
			Aeroterm	2
			Trammel Crow	1
			American Airlines	2
			Cathay Pacific	1
			China Airlines	1
			China Cargo	1
			Emirates	1
			Korean Air	2
			Lufthansa	1
			Singapore Airlines	2
			Air General	1
			Menzies	2
			Cargo Airport	1
			Integrated Airline	3
			Worldwide Flight	3
			Blakeman	1
			BTX Global	1
			Cavalier Logistics	1
			Landstar	1
			Mexpress	1
			The I.C.E. Co., Inc.	1
			Hillwood Properties	1
			Landstar	1
			Mexpress	1
Denver International Airport (DEN)				
DEN	Webber	WAC	Airport Planning	5
			UPS Station	1
Des Moines International Airport				
DSM	Webber	WAC	DSM Airport	2
			Iowa Dept. of Transportation 1	1
			Iowa Econ. Dept. Authority-Intl. Trade	1
			UPS Station Manager	1

Interviews Conducted				
Airport	**Staff**	**Lead**	**Participants**	**No. of Attendees**
Dulles International Airport (IAD)				
IAD	Davis	CDM	Airport Planning	2
			Airport Cargo Management Dept	1
			Worldwide Flight Services	1
			UPS Station Manager	1
General Mitchell International Airport				
MKE	Miller	AREA	Airport Planning	2
			Quality Air Forwarding	1
			UPS Station Manager	1
Hartsfield-Jackson/Atlanta				
ATL	Webber	WAC	Airport Planning,	3
			UPS Station Manager	1
			Cargolux Station Manager	1
			ProLogis	1
			IAG Cargo	1
			Delta Air Lines	1
			Alliance Ground International	2
			DHL	1
			Lufthansa	2
			Cumberland Commercial Real Estate	1
			NNR Global Logistics	3
			Kuehne & Nagel	1
			FedEx Station Manager	2
Indianapolis International Airport				
IND	Maynard/Miller	CDM	Airport Planning	3
			SWA	2
			Quantem	1
			IAS	1
Kansas City International Airport				
MCI	Webber	WAC	Airport Marketing	2
			Aeroterm	1
			ProLogis	1

Interviews Conducted				
Airport	**Staff**	**Lead**	**Participants**	**No. of Attendees**
			Haith & Company	1
			United Airlines	1
			Phoenix International	2
			Held & Associates	2
			Scarbrough International	2
			Laufer Group	1
King County International/Boeing Field				
BFI	Maynard	CDM	Airport Planning	1
			UPS Station Manager	1
			UPS Station Manager	2
Louis Armstrong-New Orleans				
MSY	Webber	WAC	Airport Marketing	1
			UPS Station Manager	1
			Aeroterm	1
			JW Allen Co.	1
			Irwin Brown Company	0
			Diversified Foods Inc.	1
Rickenbacker International Airport				
LCK	Maynard	CDM	CRAA Airport	3
			AirNet	1
			UPS Station Manager	1
			Pilot Freight	1
San Antonio International Airport				
SAT	Brimble	Lynxs	Airport Planning	2
			Southwest Airlines Properties	2
			DHL Station Management	2
			UPS Station Manager	1
			Lynxs San Antonio Cargo Port	1
Seattle-Tacoma International Airport				
SEA	Maynard	CDM	Airport Cargo	1
			UPS Station Manager	1
			Hanjin Station	1

Interviews Conducted				
Airport	**Staff**	**Lead**	**Participants**	**No. of Attendees**
			Manager	
			SWA Regional Manager	1
			Alaska Airlines Properties	2
Spokane International Airport (GEG)				
GEG	Janisse	RMJ	Airport Planning	2
			United Parcel Service (UPS)	1
			Horizon Air/Alaska Airlines (Horizon)	1
			United Airlines (UAL)	1
			Delta/Majestic Terminal Services (MTS)	1
			Customs & Border Protection (CBP)	1
			Airex Investments	1
Total				**153**