TANKERING FUEL: A Cost Saving Initiative

GRADUATE RESEARCH PAPER

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AFIT/IMO/ENS/11-06

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ABSTRACT

The practice of tankering for cost avoidance is an important technique used by commercial air carriers to reduce their operating costs. This paper examines the option of fuel tankering as a viable cost saving initiative within Air Mobility Command (AMC), the United States Air Force and the Department of Defense. It explores the history and theory of research done in the field of study as well as current practices, models, and flight programming software used in the commercial sector, specifically with Atlas Air, Continental Airlines, FedEx and UPS. It identifies the factors and guidelines that should define an Air Mobility tankering program. A simple model compares fuel costs of historical flights completed without tankering to the respective fuel costs of the same flights with tankering, and demonstrates potential tankering savings of up to $111 million per year . The model also enables AMC to determine if a planned flight should consider tankering, and if tankering is used, it estimates the total dollars saved in cost avoidance for that flight. The paper also identifies positive and negative factors the Air Force would need to address if it implements such a program. The final section identifies factors AMC should consider in any tankering implementation program, focusing on overall safety and training while maximizing potential savings.

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Part I

INTRODUCTION

General Issue

The Department of Defense (DoD), the United States Air Force (USAF), and Air Mobility Command (AMC) need to save money where ever possible. The potential exists to save a significant amount of money by adopting a commercially used practice known as tankering for fuel cost avoidance. This paper will identify why it is important to consider tankering as a cost-avoidance option for the DoD, explore the history of research done in the field and current practices in the commercial sector, identify the factors that should define an Air Force Program, demonstrate potential cost savings, and identify positive and negative factors the Air Force would need to address if it implements such a program.

Background and Motivation

The Department of Defense is the largest user of petroleum products government-wide in the United States. Figure 1 shows that within the DoD, the USAF uses 64% of all fuel, and of that, AMC uses 52% (AF Energy Plan, 2010:3-4). These high usage rates, coupled with the recent increase in fuel prices, result in exorbitant fuel bills compared to the respective costs incurred just six or seven years ago. The USAF alone consumed approximately 2.5 billion gallons of aviation fuel in 2008, costing $7.56 billion (AF Energy Plan, 2010:3-4). The USAF and AMC have been challenged to save money in this era of high fuel costs and fiscal austerity. The most obvious way to do this is to use less fuel; however, another option is tankering – paying less on average for each gallon of fuel burned. “Tankering, the purchase of fuel in excess of that immediately required for the next flight leg, simply means topping off the tanks at the cheaper stations to the extent the increased burn penalty and station supply allow" (Nash, 1981:1). Some of the tankering terms in this paper are not commonly used. Therefore, Table 1 provides a list of aircraft and tankering terms and their

definitions.

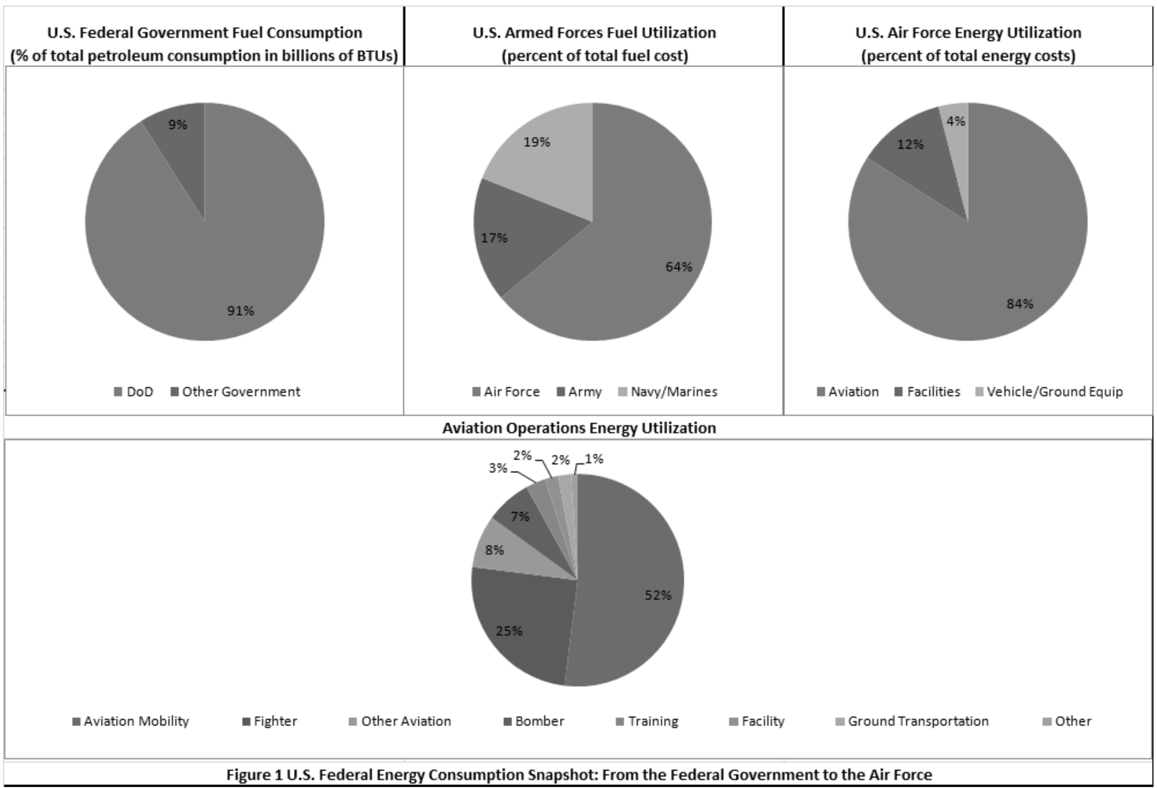

Figure 1: U.S. Federal Energy Consumption Snapshot: From the Federal Government to the Air Force (AF Energy Plan, 2010:3-4).

The USAF may be missing out on significant cost savings because of the emphasis on purely limiting total fuel consumption rather than focusing on the total cost of that fuel. Tankering fuel for cost avoidance is a proven and practiced cost saving tool that the commercial sector has adopted. It calculates the cost savings available by tankering fuel from a sortie's origin (if fuel were available at a lower price) to its destination/arrival point (where fuel may cost more) in order to avoid buying fuel at the higher priced station. Commercial airlines have achieved between 2 and 10 percent cost savings on individual flights and 5 to 6 percent on their overall fuel expenses (Stroup and Wollmer, 1992: 236-237).

Table 1: List of Terms (The Boeing Company, 2010:Ch 5.; Lockheed Martin Aeronautics Company, C-5, 2008:Ch 5; Lockheed Martin Aeronautics Company, *C-130* 2010:Ch 5; McDonnell Douglas Corporation, 2010:Ch 5; Hebco, Inc, 2009:Ch 3)

Zero Fuel Weight (ZFW)	The Zero Fuel Weight (ZFW) of an airplane is the total weight of the airplane and all its contents, minus the total weight of the fuel on board. This can include fuel required for ballast.
Cost of Weight/ Cost of Carry	The cost associated with carrying extra weight (fuel) a given distance over a given time period. Each aircraft will have a different value depending on its efficiency (Cyintech, 2008:1).
Tankering/ Economic Fueling	The purchase of fuel in excess of that immediately required for the next flight leg. Topping off the tanks at the cheaper stations to the extent the increased burn penalty and station supply allow (Nash, 1981:1).
Max Take-Off Weight (MTOW)	The maximum weight that the aircraft can take off with to include fuel, cargo and aircraft basic weight. MTOW is different for each aircraft and is dependent on atmospheric conditions and length of the runway.
Max Landing Weight (MLW)	The maximum weight the aircraft can land with to include fuel, cargo and aircraft basic weight. It is different for each aircraft and is dependent on atmospheric conditions and length of the runway. It is normally less than the MTOW and is limited by the structural limitation of the landing gear.
Max Tank Capacity	The maximum amount of fuel a given aircraft can actually carry in its tanks.
Tankered Fuel	Fuel transported from point of departure to destination for cost savings, convenience, or follow-on mission requirements, but not designated for burn on current mission leg.

The balance of expenses to profitability is in large measure tied to the rising cost of and volatility in the price of fuel. Since these costs vary continuously, it is extremely important to understand them thoroughly. Wells highlights the volatile history of fuel prices:

> Between 1978 and 1981, the price of jet fuel increased by over 153 percent, rising to a peak in May 1981 of $1.052 per gallon in domestic markets and $1.168 in international markets…in 1990, starting with the heating oil crisis that raised the price of jet fuel by a third, prices soared. Stimulated by the Iraqi invasion of Kuwait, jet fuel, which had sold for as low as 60 cents per gallon, moved very quickly to more than $1.10 per gallon…Jet fuel climbed from $0.71 per gallon in 2002 to $1.15 per gallon in 2004. In August 2005…jet fuel hit a high of $1.87 per gallon as a result of Hurricane Katrina hitting the Gulf Coast region of the United States where much of the country's oil and fuel supplies are stored…It is estimated that every 1 cent per gallon increase costs the industry approximately $160 million (Wells, 2004:187-188).

The volatile price of fuel and long term trend of price increases makes it important to find ways to manage fuel costs as much as possible. The USAF has gone through multiple changes in its fuel usage policy. Fuel efficiency and minimal fuel usage were not always a priority. Less than a decade ago, it was very common for aircraft to have a standard ramp load (an amount of fuel on board that would easily meet the need of the required fuel on a given mission). It would also be common for aircraft commanders to put an extra amount of fuel (usually 15-45 minutes extra) for "mom and the kids." This was an extra amount of fuel that went above and beyond the required safety fuel which allowed pilots to feel safer, although it was not needed. Often times, this practice undermines safety as well as effectiveness and efficiency.

The dramatic increase in fuel prices which began around 2005 caused fuel conservation to become much more important within DoD and led to clear direction promulgation in 2009. Secretary of the Air Force Michael B. Donley released Air Force Policy Memorandum 10-1 (AFPM 10-1) on June 16, 2009, in which he issued a mandate to limit fuel consumption: "the Air Force goal of reducing aviation fuel-use per hour of operation by 10% (from a 2006 base line) by 2015" (Donley, 2009:9). The Air Force emphasis on reducing the amount of fuel the Air Force uses is not new. Several recent projects examine how to more efficiently operate the Air Force aircraft fleet. Major Phil Morrison researched *Reballasting The KC-135 Fleet For Fuel Efficiency* (reduced the zero fuel weight of the aircraft); in 2009 Ray P. Matherne researched *Fuel Savings Through Aircraft Modification: A Cost Analysis* (the addition of winglets to KC-10 and KC-135 aircraft); and in 2008 Major Phil Heseltine researched *Analysis: KC-135 Lean Fuel Operations* (fuel loading aircraft to the calculated fuel load to prevent the carrying of additional fuel, eliminating the standard ramp fuel) (Morrison, 2010:1; Matherne, 2009:1; Heseltine, 2008:1). All of these projects were very successful in proving and providing various techniques that will reduce fuel consumption and help meet the cost savings goals.

This paper demonstrates similar cost avoidance opportunities by implementing a tankering program. An analysis of commercial concepts, models, and practices was conducted to define a potential tankering program for AMC and to determine if the practice of tankering fuel for cost avoidance can be a cost saving initiative for AMC.

Commercial airlines and cargo tenders use tankering to save on their fuel costs. If this proven practice can save tax payer dollars, then AMC, the USAF, and the DoD should adopt it immediately. While this process does not lower our consumption of petroleum products, it can save money. These funds can be used to develop more efficient engines, recapitalize the aging aircraft fleet and develop alternate power and fuel sources, all of which can and will lower petroleum consumption; or the funds can be used offset other funding demands in the DoD or the US Government. The author believes this practice has the potential to be implemented quickly and easily within AMC and the potential savings can reach millions of dollars.

Research Objectives, Questions, & Hypotheses

The overall objective of this research is to determine if it is beneficial for AMC to adopt a policy of tankering fuel for cost avoidance. The research questions addressed in this paper are:

1. What is the theory behind tankering for cost avoidance?
2. What are the current tankering models and programs being used today in industry and how well do they work?
3. What information is needed to create a real-time planning tool to make tankering decisions daily?
4. What are the positives and negatives of implementing such a program?
5. What factors do AMC need to consider and how much money would it save?

Derived from these questions, the research hypothesis is as follows:

The researcher hypothesizes that there is a potential for significant cost savings within AMC and the USAF with minimal safety concerns and minimal infrastructure or manning additions if the tankering process is adopted. Commercial carriers have used tankering as an effective tool to manage fuel and operations costs. The USAF should understand the uses and limitations of tankering models to move forward with the practice. Tankering for cost avoidance has the potential to save millions of dollars in fuel cost for the USAF and DoD.

Focus

Using historical route, cargo, and fuel price data from the Defense Logistics Agency-Energy (DLA-ENERGY), the 618th Air and Space Operation Center (AOC), and the AMC Fuel Efficiency Office's Mobility Air Force Fuel Tracker, an analysis was made to determine if AMC can save money if its aircraft tankered fuel on applicable missions. The analysis was completed using Microsoft Excel 2007®. This analysis focused on AMC aircraft (C-5, C-17, C-130, KC-10, and KC-135) transiting between DoD installations, commercial airports with DoD contracts, commercial airports without DoD contracts, and North Atlantic Treaty Organization (NATO) airfields. Each of the location types has a different fuel price and these are the only four price categories which were analyzed. Special attention was given to determine the variables used and the weighted priority that each variable is given in order to minimize fuel costs, while also maintaining safety and taking into account additional maintenance costs. The analysis also identified tactics, techniques, and procedures which should be used within the tankering program for it to be as successful as possible.

Chapter 2 presents a literature review of the past research completed in the field of tankering along with a view of current practices by several commercial companies. Chapter 3 details the research methodology used to develop the tankering model and examine the historical data. The results and analysis are presented in Chapter 4, followed by a conclusion, recommendations and potential areas for follow-on study resulting from the research in Chapter 5.

Part II

LITERATURE REVIEW

This literature review examines past and current practices, studies, and models showing the potential benefits and associated costs and risks of tankering fuel. It provides an understanding of when and why companies have adopted such practices and how they continue to use and optimize them. It contains inputs from Atlas Air, Continental Airlines, FedEx, UPS, and other aviation related companies and experts in the field of study.

Air Force Guidance on Tankering:

Tankering is not mentioned very often within the Air Force's flying directives, publications, or regulations. In those documents, the focus is on fuel costs, and savings center on fuel conservation. AMC Pamphlet 11-3 was a short ten page booklet published by AMC to place a significant focus on fuel conservation. It discussed helpful tips to save money on fuel costs such as selecting the shortest taxi routes, loading cargo to an aft center of gravity, and correctly trimming and maintaining a clean aircraft. The three main points were to fly at optimum altitude and airspeed while eliminating any excess weight. It was a very helpful guide that that was informational and not directive. It was within this pamphlet that tankering was mentioned, stating:

> Tankering fuel will be justified solely by mission requirements and must be authorized by the controlling agency and/or published in the mission

> directive. Tankering fuel for convenience is strictly prohibited. When flying through a station with a known high cost for fuel, consider tankering fuel if you can get a significant net cost savings and it doesn't negatively impact the mission (ramp weights, ACL, takeoff/landing distance, etc.). Fuel prices for 2006 are $2.14/gallon for contract locations that take the fuels identaplate, $2.38 for fuel received from a government contracted source (into-plane), and $3.22 for non-contract locations. These prices are subject to change. To locate DESC into-plane contractors and current rates go to: https://www.airseacard.com/training. (AMC Pamphlet 11-3, 2007:4)"

This guidance did not promote a culture of tankering for cost avoidance. The pamphlet did put the onus of tankering on the flight planners and dispatchers. Tankering fuel should not be an individual pilot's decision nor should it be a waivered type of event; it needs to be a practice that is used whenever the benefit exists.

While this paper was being written, AMC rescinded AMC Pamphlet 11-3 and started to add more "fuel conservation and cost saving initiative" language into specific aircraft regulations and instructions. The author believes this is a great step in the right direction as this will strengthen the policy and make it more directive in nature. Tankering must be in the deliberate planning process and organizationally adopted as part of the mission planning cycle for it to be successful.

DLA-ENERGY – How Fuel is Purchased in the DoD and How AMC is Charged for it

"DLA Energy's mission is to provide the Department of Defense and other government agencies with comprehensive energy solutions in the most effective and efficient manner possible." (DLA-Energy, 2010). It is not fair nor the goal of this paper to compare DLA-Energy's practices to the commercial sector. DLA-Energy standardizes the price of fuel over a long term period. This allows the AMC to properly budget for fuel over a one year period, which is critical to add stability to the planning and budgeting process. DLA-Energy removes the volatility that the commercial sector deals with daily. Within this pricing standard however, there still exists a potential for savings using a tankering program.

The critical variables influencing the tankering decision are the price of fuel at origin, price of fuel at destination and the cost to carry the extra fuel. AMC aircraft pay different prices for fuel at different fueling sites. These costs can range from 15% to over 200% (in two locations) more than DoD base fueling prices (DLA-ENERGY, 2010). The cost of carrying extra fuel onboard aircraft is known as cost to carry/cost of weight. Despite this cost, there is a point at which the higher price of fuel at a destination would justify the additional carrying cost and achieve substantial cost savings.

AMC is charged four different 'standard' prices for fuel purchases depending on which airfield its aircraft purchase fuel at as seen in Table 2.

Table 2: Latest Standard Fuel Prices (DLA-ENERGY, 2010).

Location	**Price**	**Price as of Date**
Defense Fuel Supply Point (DFSP), JP-8 (DoD Locations)	$3.03	1-Oct-10
Jet A Into-Plane (Commercial Fields, Contracted)	$3.46	1-Oct-10
NATO F-34 Local Purchase (NATO Serviced Fields)	$6.50	1-Oct-10
Jet A Non Contract Source at an Airport (Commercial Fields, Non-Contracted)	$4.27	1-Oct-10

The DLA-ENERGY explanation of the standard price of fuel from its help center is s follows:

> What the Standard Price of Fuel is:
>
> The standard price of fuel is a tool that was created by DoDs fiscal managers to insulate the Military Services from the normal ups and downs of the fuel marketplace. It provides the Military Services and OSD with

> budget stability despite the commodity market swings, with gains or losses being absorbed by a revolving fund known as the Defense Working Capital Fund (DWCF). In years that the market price of fuel is higher than the standard price, the DWCF loses money. In years that the market price is lower than the standard price, it makes money. This gain or loss can be made up by adjusting future standard prices or by providing our DoD customers with a refund. This decision is typically made by the Office of the Secretary of Defense, Comptroller. However, the DWCF must remain cash solvent. As a result, in rare instances such as fiscal year 05, the standard price is changed during the fiscal year so the fund remains solvent.
>
> The standard price is established well in advance of the fiscal year it is used. It is built by assembling the following blocks:
>
> A projection of the price of fuel 18 months in the future. (In the late fall the standard price is determined for fuel that will be sold to our customers during the Fiscal Year. As an example in the fall of 2005 the price is set that will be in effect from October 06 through September 07.)
>
> The budgeted cost of transporting, storing, and managing the government fuel system, including war reserve stocks and some adjustment to these costs which reflects whether the revolving fund lost or gained money during the previous years.
>
> What the Standard Price of Fuel is not:
>
> The standard price of fuel is not a marketplace price. You cannot compare the standard price of fuel with the price of fuel at the service station down the block. It is not intended that the standard price of fuel be comparable with similar fuels in the commercial marketplace (DLA-ENERGY, 2010).

The standard price of fuel is set for each of the four different price points that AMC purchases fuel. It is also important to point out that the standard price has been changing much more frequently because of the recent commercial price volatility. This is clearly visible in Figure 2.

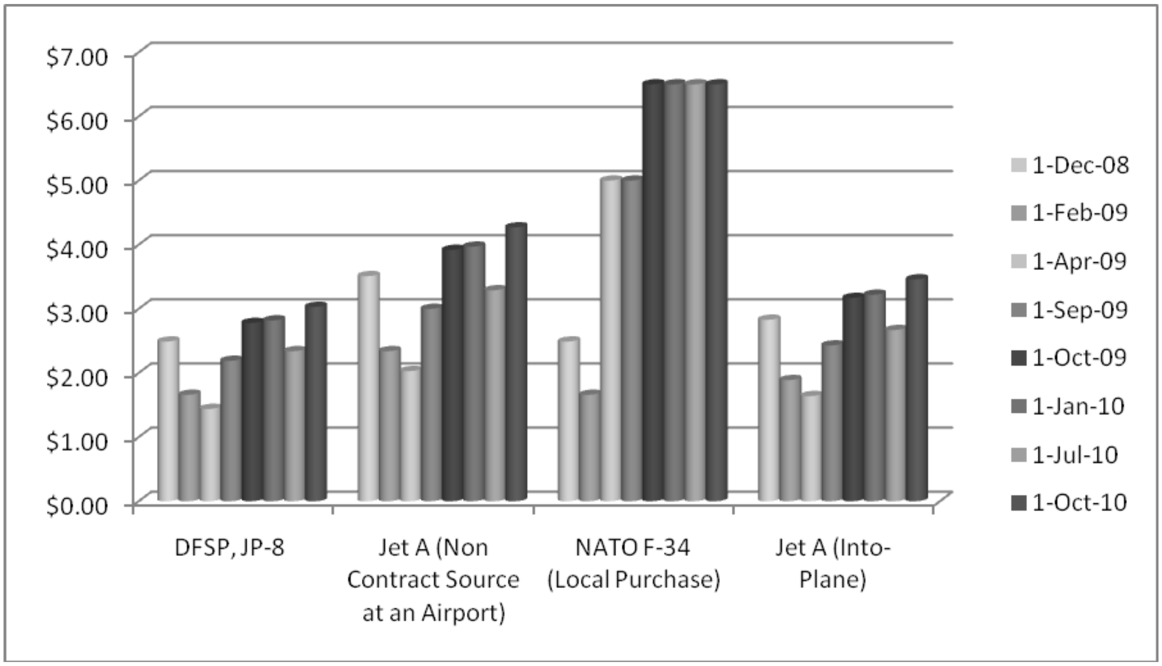

Figure 2: Recent History of Standard Fuel Price (Built from source data) (DLA-ENERGY, 2010)

A Defense Fuel Supply Point (DFSP) is a fueling station at a major U.S. military installation (see Appendix A for the complete list as of 1 Jan 2011). This includes all stateside bases and most of the overseas bases. The price of fuel at DFSPs serve as the baseline price for this research. DFSPs in Iraq and Afghanistan provide fuel for the Forward Operating Bases (FOBs) at the $3.03 standard price throughout Iraq and in Northern Afghanistan **(**DLA-ENERGY, 2010).

The next most common location where AMC obtains aircraft fuel are civilian airfields where DLA-ENERGY has fueling contracts already established and are referred to as into-plane locations. These locations offer DoD customers fuel at the second (Table 2) standard price of $3.46. If an AMC aircraft fuels there, AMC is charged the into-plane 'standard' price which is approximately 15% more than the base Defense Fuel Supply Point price of $3.03. This into-plane 'standard' price is determined by DLA-ENERGY by averaging all of the contracted prices between the individual location and

DLA-ENERGY. A complete list of all current contracted prices (as of December 2010) can be found in Appendix B. Table 3 shows an abbreviated portion of the list **(**DLA-ENERGY, 2010).

Table 3: Breakdown of Into-Plane Fuel Contracts (DLA-ENERGY, 2010)

ICAO	State	Vendor Name	Contract SP0600-	Contract Period	Quantity	Award Price	Total Dollar Value
KABI	TX	ABILENE AERO INC.	07-D-0053	04/01/07 - 03/31/11	1,145,512	$3.00	$3,431,381
KSPI	IL	AIR BP	08-D-0069	11/01/08 - 09/30/12	909,527	$3.76	$3,421,094
DNAA	OS	TOTAL SA DBA TOTAL	10-D-0071	10/01/10 - 09/30/13	187,350	$3.00	$562,190
KARA	LA	PELICAN AVIATION CORP	07-D-0103	05/01/07 - 03/31/11	1,646,112	$2.93	$4,830,680
KARA	LA	PELICAN AVIATION CORP	07-D-0103	05/01/07 - 03/31/11	847,738	$2.86	$2,424,191
DGAA	OS	TOTAL SA DBA TOTAL	10-D-0066	04/01/10 - 09/30/15	50,000	$3.20	$159,770
PADK	AK		PENDING		169,612	$0.00	$0.00
KLIT	AR	CENTRAL FLYING SERVICE INC.	07-D-0101	04/01/07 - 03/31/11	1,495,804	$2.79	$4,177,481
KADS	TX	ENCORE FBO ACQUISITION LLC	10-D-0001	10/01/09 - 03/31/11	60,000	$4.23	$253,530

As seen in Table 3, the contracted prices between DLA-Energy and the vendor differ by locations. However, to simplify and standardize the process, DLA-Energy charges AMC the same price no matter which into-plane location the aircraft refuels at, the into-plane standard price, currently at $3.46. While not the primary focus of this paper, additional savings may be possible at higher levels within the DoD by taking advantage of these price differences. Multi-year contracts are the DLA-ENERGY standard, and they are only generated when a service component (i.e., Air Force, Army, Navy, …) requests one be sets up. The contracts are flexible: as the price of fuel changes, the awarded price changes. DLA-ENERGY reviews its contracts annually and on a regional basis. These reviews generate frequent updates to the program and are reflected in a timely manner. They may be viewed at https://ports.desc.dla.mil/ip_cis/ipcis.htm **(**DLA-ENERGY, 2010).

Another standard price that AMC pays is the NATO fuel price. This price currently affects only two NATO airfields, both of which are located in the Afghanistan area of operations; the price is a NATO- Base Operation Authority (BOA) price, not DLA-ENERGY generated, and billed to the service through DLA-Energy. The $6.50 per gallon price is approximately 215% higher than the DoD standard price at $3.03 per gallon. NATO fuel price points are set by Supreme Group--the NATO fuel supplier **(**DLA-ENERGY, 2010)--and are considered to be the only price that reflects the fully-burdened costs (transportation, storage, management, security, etc.,) which is directly passed on to the customer.

The final standard fuel price is the non-contracted price, which encompasses those airfield locations that do not fall into any of the other categories. There is not an official list of these fields; however, a list generated by this research (current as of December 2010) is located in Appendix C. The current AMC standard price is $4.27 a gallon or 40% more than the DoD standard DFSP price. DLA-ENERGY will normally contract a price with these locations after the fact and if it is going to become a common fueling location, it will be added to the into-plane database via contract **(**DLA-ENERGY, 2010).

Historical Review - Initial Tankering Models:

Barry Nash (1981) was one of the earliest researchers to work with tankering models. His paper's brief history was ideal to setting the stage at the time and still holds true today:

> Since the early part of 1974, a number of airlines have been developing least cost fueling strategies for their flights through use of mathematical formulations and computer techniques. Events subsequent to the Arabian oil embargo of 1973 contributed to a doubling in six months of the average cost per block hour of aircraft utilization. As expenditures for fuel, oil, and related taxes grew to become the lion's share of operating costs, airlines were forced to emphasize fuel conservation. Studies to determine the effects on fuel burns of lowering cruise speeds, decreasing taxi distances, using more efficient glide paths, lowering holding delays, and redesigning engines and airframes were conducted. (Nash, 1981:1)

Nash used this motivation to produce a linear programming model to develop a simple and inexpensive alternate to the complicated programs run by what was then a "super" computer (not available to everyone). The assumptions of one vendor per station, one price per station, and linear dependence of excess fuel burn versus aircraft weight simplified his work and served as a very good baseline for the operational constraints that the USAF uses to purchase fuel. Nash's linear program determined the lowest overall cost for Frontier Airline's flight from Denver (DEN) to Kansas City (MCI) to Saint Louis (STL) to Topeka (FOE) back to Denver (see Figure 3). Fuel prices varied at each location and the

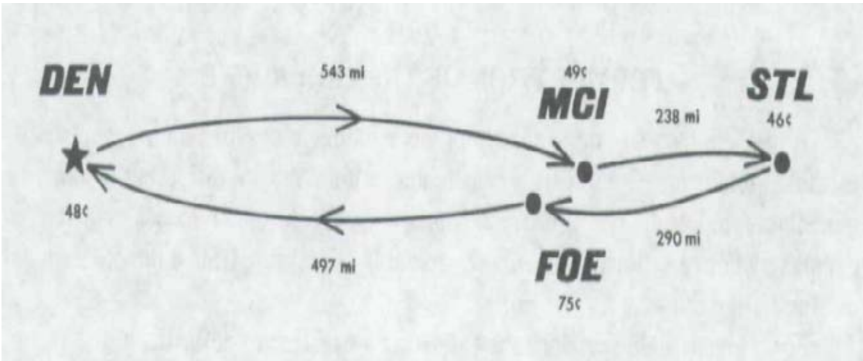

Figure 3: Diagram of Flight Loop Giving Fuel Prices at Airports and Flight Distances Between Them (Nash, 1981:4).

linear program determined whether it was less expensive to carry extra fuel from the station prior (factoring in a cost to carry penalty) or if it was cheaper to refuel at that location. The linear program also allowed for the ability to look at the problem as a multi-leg model, meaning that the linear program is programmed to tanker fuel, if needed, all the way from Kansas City to Topeka, if Saint Louis would not have enough fuel to provide or if it is priced too high. Nash's model demonstrated the potential of over $100,000 in cost avoidance in just three months time with relatively small implementation costs ($300 for computers) and man-hours requirements (32-40 hours per month) (Nash, 1981:3-6).

Zouein, Abillama, and Tohme examined cost savings associated with tankering fuel from low cost locations through follow-on airfields offering fuel at a higher price. The authors defined this study as a fuel management problem with a multiple period capacity inventory issue, solving for an optimal uplifted fuel load. They used a simple comparison of actual costs against that of projected fuel costs to establish the tankering model for a single leg without any supply or inventory constraints. Zouein, Abillama and Tohme went a few steps further than Nash and established a strong correlation (.88) with a linear

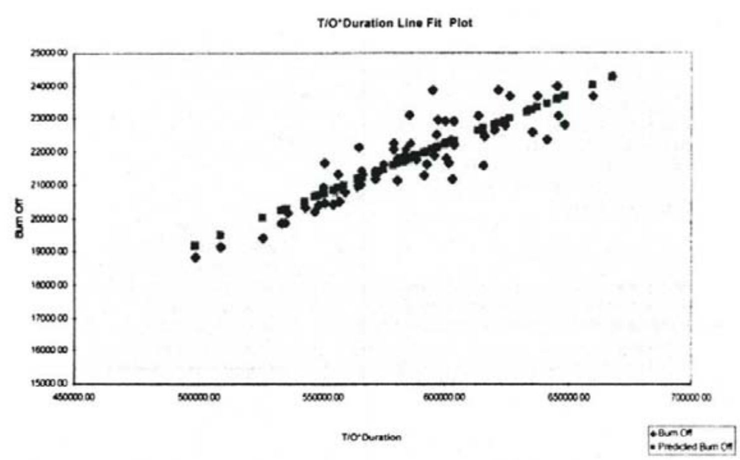

Figure 4: Plot of the Data and the Best Fitted Regression Function for the Beirut-to-Paris Flight of the A310-300 Aircraft (Zouein, Abillama and Tohme, 2002:381).

regression analysis between the amount of fuel consumed during a flight leg and the flight duration for a given aircraft at a specific takeoff weight (see Figure 4). This is a commonly known value in the flying community and is used as an important baseline within this research paper. The data set also showed flight duration times for the A310-200 between 4.42 hours and 5.17 hours. The authors include some constraints that were not addressed in Nash's article (such as take-off and landing weight limits, fuel capacity, and fuel safety margins). Their study covered all aircraft types in the Middle Eastern Airline (MEA) fleet and concluded that a 10% savings in fuel cost could be realized without a major investment on the part of the participating airline. Figure 5 shows the detail in cost savings versus the increase consumption in fuel (Zouein, Abillama and Tohme, 2002:379-385).

Aircraft type	*MEA consumption (kg)*	*LP consumption (kg)*
A 310-200 I	220 920	222 362
A 310-200 II	247 940	260 384
A 310-200 III	264 510	268 943
A 321 I	116 350	119 763
A 321 II	162 300	164 529
A 320 I	101 480	100 583
A 320 II	174 220	188 254
A 310-300 I	227 760	226 255
A 310-300 II	275 370	286 261
Boeing 747 I	620 200	635 003
Boeing 747 II	917 400	920 676
Boeing 747 III	488 000	504 505
Total	**3 816 450**	**3 897 518**

Aircraft	*MEA fuel cost ($)*	*LP total cost ($)*	*Savings ($)*
A 310-200 I	57 375	48 725	8650
A 310-200 II	66 829	59 358	7471
A 310-200 III	61 369	59 153	2216
A 321 I	28 875	27 250	1625
A 321 II	38 820	35 729	3092
A 320 I	26 992	23 309	3684
A 320 II	45 574	42 889	2685
A 310-300 I	54 703	53 562	1140
A 3 10-300 II	74 090	68 884	5206
Boeing 747 I	160 419	142 524	17 895
Boeing 747 II	180 992	161 656	19 336
Boeing 747 III	132 813	117 890	14 923
Total	**928 850**	**840 927**	**87 923**

Figure 5: Demonstrated Cost Savings with an Increase in Fuel Consumption (example 1) (Zouein, Abillama and Tohme, 2002:385).

Stroup and Wollmer also used an LP approach to determine minimal fueling costs by taking station and supplier constraints into account. They showed how fuel cost minimization can be solved as a pure network problem when station and supplier constraints are constant, or solved as a generalized network flow problem when only one of the two variables are constant. Their model was used by McDonnell Douglas and resulted in a savings of 5-6% with Brazilian airline VASP (Viacao Aerea Sao Paulo) during short and medium range flights. Required data included aircraft schedules, fuel consumption by flight leg as a function of the landing fuel, fuel prices, fuel availability at stations and vendors, maximum take-off weight and landing weights, and minimum reserves required for landing. Savings on specific flights were as high as 10.69%. Figure 6 highlights the data set and demonstrates the savings/cost avoidance capable on a specific flight (Stroup and Wollmer, 1991:229-237).

The literature provides a solid baseline for this study. The basic premises behind these solutions are what laid the framework for the commercial tools that are used today. Commercial companies use different software programs to execute their tankering cost avoidance programs. These high tech "fifth generation" flight planning systems take much more into account than just tankering; however, for the purposes of this research, tankering is the focus when looking at all of these companies and their flight planning programs.

Current Commercial Practices and Results:

Between 1 October 2010 and 1 February 2011, multiple face to face and telephone interviews were conducted with Atlas Air, Continental Airlines, Fed-Ex, and UPS to determine best practices and savings achieved using tankering. Individuals at each of the companies provided estimates of cost savings achieved by tankering, current policies that guide their tankering programs, and any specific lessons that would be helpful in creating a new program for AMC. The amount of information disclosed varied due to the highly proprietary nature of the business.

Input Data for Flights 284 and 285[a]

From	To	Fuel Cost	Fuel Consumption	Minimum Reserve	Maximum To Fuel	Maximum Landing Fuel
SAO	GIG	0.09060	$6{,}608 + (0.0300)y$	14,060	26,000	32,000
GIG	BSB	0.09060	$12{,}005 + (0.0580)y$	15,600	52,460	35,000
BSB	THE	0.09060	$15{,}281 + (0.0680)y$	13,950	52,460	39,000
THE	SLZ	0.12110	$6{,}097 + (0.0100)y$	13,270	35,000	35,000
SLZ	BEL	0.09610	$7{,}834 + (0.0200)y$	12,800	52,000	41,000
BEL	SLZ	0.09060	$7{,}857 + (0.0260)y$	13,200	52,460	35,000
SLZ	THE	0.09610	$5{,}929 + (0.0220)y$	15,940	47,000	36,000
THE	BSB	0.12110	$15{,}908 + (0.0720)y$	15,150	36,000	36,000
BSB	GIG	0.09060	$12{,}380 + (0.0440)y$	14,760	52,460	36,000
GIG	SAO	0.09060	$7{,}933 + (0.0200)y$	12,400	52,460	39,000

[a] The first five lines are for flight 284 from São Paulo to Belem and the last five lines are for the return flight 285 from Belem to São Paulo. Fuel cost is measured in dollars per pound and all other inputs are measured in pounds. The quantity y represents the fuel weight when landing at the destination city.

Minimum Cost Output for Flights 284 and 285[a]

From	To	Fuel Loaded	Fuel Cost	To Fuel	Fuel Burned	Landing Fuel
SAO	GIG	8,689	787.22	21,089	7,030	14,059
GIG	BSB	14,449	1,309.08	28,508	12,909	15,599
BSB	THE	20,506	1,857.84	36,105	16,606	19,499
THE	SLZ	0	0.00	19,499	6,230	13,269
SLZ	BEL	7,619	732.19	20,888	8,088	12,800
BEL	SLZ	30,966	2,805.52	43,766	8,766	35,000
SLZ	THE	3,785	363.74	38,785	6,637	32,148
THE	BSB	0	0.00	32,148	16,999	15,149
BSB	GIG	12,639	1,145.09	27,788	13,029	14,759
GIG	SAO	5,820	527.29	20,579	8,179	12,400
		104,473	$9,527.97			

[a] The first five lines are for flight 284 from São Paulo to Belem and the last five lines are for the return flight 285 from Belem to São Paulo. Fuel cost is measured in dollars and all other outputs are measured in pounds.

Output for Flights 284 and 285 When Plane Refuels at Every Stop[a]

From	To	Fuel Loaded	Fuel Cost	To Fuel	Fuel Burned	Landing Fuel
SAO	GIG	8,689	787.22	21,089	7,030	14,059
GIG	BSB	14,449	1,309.08	28,508	12,909	15,599
BSB	THE	14,579	1,320.86	30,178	16,229	13,949
THE	SLZ	5,549	671.98	19,498	6,229	13,269
SLZ	BEL	7,619	732.19	20,888	8,088	12,800
BEL	SLZ	8,600	799.16	21,400	8,200	13,200
SLZ	THE	9,019	866.73	22,219	6,280	15,939
THE	BSB	16,208	1,962.79	32,147	16,999	15,149
BSB	GIG	12,639	1,145.09	27,788	13,029	14,759
GIG	SAO	5,820	527.29	20,579	8,179	12,400
		103,171	$10,102.37			

[a] The first five lines are for flight 284 from São Paulo to Belem and the last five lines are for the return flight 285 from Belem to São Paulo. Fuel cost is measured in dollars and all other outputs are measured in pounds.

Figure 6: Demonstrated Cost Savings with an Increase in Fuel Consumption (example 2) (Stroup and Wollmer, 1991:236-237).

FedEx uses Jeppesen Flight Planning software for its flight planning and tankering program. During the time period from June 2009 to May 2010, 12% or 24,565 of 202,982 flights tankered fuel, resulting in cost avoidance to FedEx of $7,566,061 (FedEx Team, 2010).

United Parcel Service (UPS) uses flight planning software developed by Lufthansa Systems called Lido/Flight. This is a very robust system with many great capabilities. It has the capability to tanker based on one or more legs. It will tanker in order to: obtain the lowest fuel costs, meet a guaranteed upload from a given distributor (allowing for negotiated low price, high volume fuel), minimize ground time, or address fuel shortages at a given airfield. The process to introduce this flight planning system was expensive, but UPS hoped to see a return on investment within 36 months. It worked so well that the investment was paid back in less than 12 months. UPS has a corporate model focused around energy procurement, from fuel storage, to hedging and buying in bulk. It lives in this culture every day; new policies and changes with respect to fuel conservation or cost reduction are easily adopted and followed by all members of the team. UPS tankers to save money, avoid fuel shortages at airports (quick acting response), and shorten ground times. UPS is careful not to penalize itself during tankering. UPS will not tanker to the maximum extent possible, because this prevents forcing an aircraft to hold in the air because it is over its landing field above maximum landing weight. The system default is a 2.0% buffer, but the UPS dispatchers can also designate a specific tankering amount to lessen the risk of overweight situations. UPS views the servicing of their customers' packages as a business priority, and will never remove packages in order to tanker fuel. A key component of the success of the UPS flight planning/tankering system is its level of automation. This automated full logic tool prevents the process from being abandoned if it were to be done manually and task saturation takes over. Finally, feedback is critical to the operation. UPS places a large emphasis on showing its dispatchers how their decisions matter and how the extra time it takes to create a quality cost saving product affects the bottom line of the company. During the time period from January 2010 to September 2010, 22% or 27,500 of 124,600 scheduled UPS flights tankered fuel for economic reasons. This resulted in cost avoidance for UPS of over $7.8 million (Dunn, 2010).

Atlas Air uses a flight programming system called flywize created by f:wz aviation software, a wholly-owned unit of Dubai Aerospace Enterprise (DAE) Services and recently purchased by Sabre in September 2010. As with many of the other software packages, its primary purpose is to increase efficiency and generate significant cost savings. It takes advantage of technology and is designed to optimally manage air and ground assets to meet mission objectives, lower operating costs and reduce emissions. According to Atlas Air manuals, they tanker fuel for four primary reasons:

- To take advantage of fuel price differential where cost at the departure station is lower than fuel costs at the destination.
- To expedite downline transits when extra fuel is not an economic penalty.
- When fuel is in short supply, or not available at the destination.

  Note: In this case, fuel will take precedence over payload. The dispatcher will ensure the amount of tankered fuel is the minimum amount needed to depart the destination station with the minimum required plus taxi and APU burn.

- Operational reasons, when necessary, such as slow ground fueling systems to save on turn times (Kappen, 2011).

On the other hand, Atlas manuals outline the following four reasons for when not to tanker:

- When engines are on a temperature watch (high EGT).
- Higher fuel uplift requirements can lead to fueling delays. If a fueling delay is imminent, dispatchers shall consult with System Control to consider the affects of keeping the delay or amending the flight release to remove tankering.
- For certain inoperative items
- At highly specialized airports (Kappen, 2011).

It was further emphasized that the last two items are heavily debated. The inoperative items restriction is decided upon by their flight operations group. In past experiences, they start with limitations and then remove them. Inevitably, with limitations, something would always come up (e.g. no fuel at the destination). This situation would require tankering fuel and waivers or special authorization would be needed. It was cautioned to be careful with wording if writing restrictions into the MEL. With regards to highly specialized airports, it again would be decided by the flight operations group. The group would have to find a balance between flight safety and risk versus cost. Atlas currently does not prohibit any airport from having tankered fuel (Kappen, 2011).

Greg Kappen of Atlas Air, gave an example from a previous commercial job working with the A320. A planning factor in this aircraft allowed for tankering fuel to 2,000 pounds below max landing weight to prevent the aircraft from having to hold at the airport when the winds allowed for shorter flight. Atlas defines its landing gross weight tankering restriction for its 747 fleet in its manuals to 3000 kilograms of fuel below maximum landing gross weight (Kappen, 2011).

Continental Airlines uses an algorithm called Phoenix built by Electronic Data Systems (EDS) which automatically displays to the dispatcher the possibility of tankering fuel or not and if so how much additional fuel to carry. While it is an older software package, Phoenix is currently meeting Continental’s needs. Prior to merger talks with United, they built a new generation flight planning software with Hewlett-Packard. This software will go unused as Continental will flight plan with the United Airlines Software package, flywize made by f:wz. Continental previously tankered on 30-40% of flights, but more recently with higher prices across the world and more efficient aircraft the totals are more toward 15-20%. This reduction can be accounted for because of the overall increase in fuel prices and the purchase and use of more efficient aircraft which causes many of the flights to be limited by landing weight. From January to November 2010, Continental tankered fuel on 13.5% or 45,275 of 334,000 flights with a savings or cost avoidance of almost $5.5 million. The greatest savings were seen in the winter, whereas the summer months showed the lowest cost avoidance. This is expected as aircraft can take off heavier (carry more tankered fuel) when the temperature is colder, all other factors being the same. Phoenix accesses a database of fuel prices that is updated daily by the fuel team of about six people. When tankering, Continental will limit the amount it tankers to either as much fuel as the tanks can hold, the max take-off gross weight, or 1,000/2,000 pounds below max landing weight for narrow/wide bodies. It also does not apply a maintenance cost penalty to its calculation. Continental believes that if it remains within the structural limits of the aircraft, there is no penalty because the plane is being flown as it should be (Dubner, 2010).

Continental Airline also saves money by using World Fuel Services as major contractor. This arrangement allows Continental to obtain a contract rate versus the spot rate that could be a dollar or two more per gallon. Consistent with the other companies, Continental’s rule is to never refuse cargo or passengers in order to tanker fuel. Tankering fuel is always a lower priority than bumping cargo or passengers. Continental does tanker for quick turns at Kuwait and military bases since many of those areas do not provide concurrent servicing. Saving the ground time can be more beneficial to the company financially. Additional steps which Continental has taken include: planning and flying at optimum altitudes and airspeeds; not flying airways but instead, flying equivalent still air distance (ESAD); and scheduling certain legs to take-off later at night to reduce fuel costs because of the cooler temperatures. Continental has made it a practice to load its aircraft within 2% of the aft/optimum center of gravity (CG). This initiative alone has saved over $5 million a year (Dubner, 2010).

Table 4 summarizes the carriers' savings through their tankering program. Table 5 summarizes the key points on the positives and negatives of tankering. Reasons not to tanker will always exist in some way or another. It is important to balance the decision of those flights where tankering is used with the determination if the cost benefits outweigh the negative risks creating a savings for the company.

Table 4: Company Comparison in Tankering Operations

Company	Time Period	Number of flights	Number of flight tankering gas	Percentage of Flights	Total cost Avoidance
Fed Ex	Jun 09 - May 10	202,982	24,565	12%	$7.6 million
UPS	Jan – Sep 10	124,600	27,500	22%	$7.8 million
Continental	Jan – Nov 10	334,000	45,275	13.5%	$5.5 million

Air Mobility Command Aircraft Data:

The research within this paper focused on AMC aircraft, specifically the C-5, C-17, C-130, KC-10, and KC-135 aircraft. There are many different variations of some of these aircraft types. Table 6 represents the limitations as set forth by the performance manuals of each aircraft. While this is not good enough for specific data that pertains to

Table 5: Reasons Why or Why Not to Tanker

Reasons to tanker fuel:	Reasons not to tanker fuel::
- Lower priced fuel at departure location in comparison to destination including the cost to carry the extra fuel (Kornstaedt, 2007:5)	- Increased fuel burn because of greater weight increment and the speed increment increase to meet a given cost index (Kornstaedt, 2007:5)
- Unreliable fuel supply or fuel quality at the destination (Boeing, 1997) (Kornstaedt, 2007:5)	- Lower optimum & maximum cruise levels resulting in reduced efficiency (higher fuel burn rates) (Kornstaedt, 2007:5)
- Ground time reduction (to meet ATC slot time), or losing money because the plane will sit on the ground to long (Boeing, 1997) (Kornstaedt, 2007:5)	- Increased thrust needed for takeoff (prevents the ability to accomplish derated or FLEX take-offs) (Hakan, 2011) (Kornstaedt, 2007:5)
	- Added wear & tear on the flaps, brakes, tires, and landing gear (Dunn, 2010) (Kornstaedt, 2007:5)

each individual tail, it is sufficient to generalize the required limitations for each aircraft. The cost to carry/cost of weight calculation is from a Cyintech report completed for AMC. The cost to carry calculation was an average of excess fuel burned for weight carried on long, medium and short duration flights (short flights are subject to a higher hourly burn rate penalty and longer flights subject to a lesser burn rate because of the increase fuel burn during take-off and climb out). The study also looked at payloads from empty to max load and did not take into account the effects of air refueling. As an example, for every 1000 lbs of weight loaded onto a KC-10, the aircraft requires 44.7 lbs of fuel to keep it airborne for 1 hour (Cyintech, 2008:1-10).

Table 6: AMC Aircraft Data (The Boeing Company, 2010:Ch 5.; Lockheed Martin Aeronautics Company, C-5, 2008:Ch 5; Lockheed Martin Aeronautics Company, *C-130* 2010:Ch 5; McDonnell Douglas Corporation, 2010:Ch 5; Hebco, Inc, 2009:Ch 3)

	C-5	C-17	C-130	KC-10	KC-135
Zero fuel weight	665,000	447,400	n/a	414,000	195,000
Operating Weight	350,000 - 400,000	276,500 w/o ER	85,000		120,000
MTOW	769,000	585,000	155,000	590,000	322,500
MLW	769,000	585,000	155,000	436,00	322,500
Fuel Capacity lbs	332,500	165,000	61,364 w/foam	364,408	209,543
Fuel Capacity gallons	48,897	26,986	9,077	54,390	31,275
Cost To Carry	5.67%	4.4%	3% *	4.47%	4.97%

*** AMC estimated Value**

Public Opinion and Environmental:

Public opinion and environmental issues cannot go without mention. The idea of burning more fuel to save money is not the most environmentally friendly concept. Common commercial belief is that the public accepts small amounts of extra fuel burned with the understanding that additional cost savings is passed on to them. The commercial argument also focuses on the idea that the money saved in tankering allows them to purchase new aircraft, in turn reducing their carbon footprint even more. The Air Force is focused on environmental issues. Initiatives are underway to further develop and use bio-fuels, however the costs here can also be a concern. The Air Force needs to do things smartly and save money. Historically, considering the limited number of missions that tankering may be used for, initiating a tanking program is a balance between cost savings now as the service investigates new initiatives for future use.

Part III

METHODOLOGY

Methodology of the Model

A great deal of information was needed from a variety of sources to develop an effective tankering model. Specific aircraft data, such as fuel capacity, allowable takeoff weight, allowable landing weight, and other specific aircraft data was gathered from technical manuals (the "dash-one" manuals) for each aircraft. DLA-ENERGY and the Mobility Air Force Fuel Tracker will be able to provide a history of fuel prices, fuel on-loads to specific aircraft, cargo loads carried during those missions and locations where aircraft were fueled during the given time period. The combination of the sources of data allows for an accurate computation of maximum allowable fuel on-load for tankering.

A two week historical review of AMC flights enabled a quick examination of potential savings from tankering. The data were obtained from the AMC Fuel Tracker. The initial data from 1 December 2010 to 15 December 2010 of 3,814 missions were reduced by deleting missions that took off and landed at the same location. It were further cut by removing missions that refueled aircraft in mid-air and aircraft that were air refueled, bringing the number relevant of missions to 2,115. Aircraft that takeoff and land at the same location are usually training lines. These flights should be fueling to the minimal levels needed to complete the required training since no tankering cost potential exists due to the same price of fuel (Heseltine, 2008:1). The refueling missions were removed to simplify the study. There is a potential for cost savings with the refueling missions but each flight must to be looked at individually--this may be an area for future research and is further discussed in Chapter V. In addition, 86 LC-130 missions were deleted. These were specialized missions which flew to Antarctica on an aircraft that does not have a computed cost of carry. Further, the missions represent a very small quantity of the overall AMC mission set and follow special rules that limit tankering abilities. This left 2,029 missions to be examined for potential tankering savings.

Within this data set, planned data for fuel, cargo, and flight time was used over actual data for fuel, cargo, and flight time. This is realistic since flights are normally planned with this data and the determination to tanker would be made at this point. In terms of fuel, 71% of the 2,029 mission had planned fuel weight greater than or equal to the actual fuel weight where the average difference in fuel was 1,300 lbs. Planned cargo weight equaled or exceeded actual cargo weight 90% of the time with the average difference being about 5,100 lbs. Finally planned flight time equaled or exceeded actual flight time 61% of the time with an average difference of .03 hours, or about 2 minutes. Using planned data gives a good representation of the overall data and errors in the conservative realm (meaning even greater savings may be realized).

The model developed is similar to simple industry models. It takes into account current practices, policies, and calculations from Atlas Air, Continental Airlines, FedEx and UPS's tankering programs that can be easily captured. Either face to face or telephone interviews were conducted with personnel from these companies to determine best practices and savings achieved using tankering. Each of these companies use advanced flight planning software to determine if their flights should tanker fuel for cost avoidance. Their software programs take many factors (current atmospheric conditions, runways length and conditions, airfield altitude, aircraft follow-on missions, over-flight fees, aircraft operating and maintenance costs, etc.) into account. Since AMC does not have software capable of such calculations, this model was created as a simple tool in order determine if a tankering profile would be cost beneficial on a given flight mission. While the model does not take into account all the specific factors used by the commercial carriers, it can be used to identify a flight for tankering and provide a fairly accurate estimate of tankering savings. To obtain a more detailed calculation, new flight planning software would be required or the current AMC planning software can be run twice to compare what it would cost to fly the flight at the lower weight versus that of the heavier weight flight (tankering fuel).

New flight planning software was not used in this model because of cost and time constraints. New flight planning software requires a database of aircraft, airfields, and flight rules to be built in order to complete calculations. Software creators charge the commercial carriers for building the database when providing the overall flight planning software. This database construction requires a great deal of time and is expensive. Current AMC flight planning software was not used because of the amount of time a comparison of different flight plans would take. Instead, a simple spreadsheet analysis, using the same calculations in the model, was used to compare costs between AMC's current practice and AMC's cost if the tankering model is used for applicable flights. Because a cost-saving potential was found, therefore this research sets the framework and theory for AMC to create or purchase an upgraded flight planning software and/or develop a policy which requires planners to determine tankering savings during real time mission planning.

Assumptions and Limitations

This research assumes that the information provided by DLA-ENERGY and the Mobility Air Force Fuel Tracker is correct and accurate. The information received during interviews and about commercial tankering models is assumed to be correct and accurate. At all times, the safety and structural limits of the aircraft are maintained. It is also assumed that for all calculations, none of the cargo or passengers are removed in order to tanker additional fuel. This assures that all required passengers and cargo is moved before fuel is tankered to avoid a second aircraft generation to complete the mission.

The amount of historical records over the past years on aircraft fueling is very extensive and time constraints prevented it from all being analyzed. The researcher selected a short time period and specific aircraft to demonstrate the potential savings across the full spectrum of missions while limiting the data sets. While it was expected that the data sets would demonstrate past savings on specific missions, the model is able to calculate the potential for savings on all missions and routes as long as the aircraft cost to carry is known.

Factors that were accounted for include the max take-off weight, max landing weight, and fuel system capacity. Factors that were not be taken into account in this model include atmospheric conditions (temperature, wind speeds, and other such conditions that affect an aircraft take off and landing capability) and airfield conditions such as runway length and weight bearing capacity. This model identified whether it is beneficial to tanker fuel based on the factors of flight time, price of fuel at the departure station, price of fuel at the arrival/destination station and cost to carry on the specific aircraft. The model however does not guarantee that the aircraft will have enough runway length to takeoff at the given location at a max take-off weight or if that airfield is even stressed for the weight of the heavier aircraft. This issue should and will be identified by the dispatcher in the flight planning software after the determination of the tankering possibility.

The model also assumes that all aircraft variants are the same. As an example, the C-5A, C-5B, C-5C and C-5M all have the same weights, cost to carry, and limitations. The model also assumes that the density of fuel (JP-8 or Jet A) remains constant with a conversion factor of 6.76 lbs/gallon. Fuel density normally changes with temperature. This assumption also falls within the MILSPEC API acceptable product range of 6.4521 and 6.9941.

The price point of $4.27 was used for the following airfields: CYQQ, EPPW, HADR, HKM1, KEAU, KHFF, LEAB, LEZG, OP12, OPTA, OYAA, OYSN, SKAP, SKTI, SOCA, TGPY, YAMB, and YSRI. These airfields did not appear on any of the provided lists for price points and therefore it was assumed that they were non-contract fields that would be charged $4.27.

Figure 7 is a screen shot of the excel model used in the project. Flight information is added into the blue highlighted cells resulting in the potential cost avoidance/savings. The right hand side of figure 7 defines the current constants of fuel price and cost to carry for each aircraft.

AMC Tankering Model				
Enter Data in Blue Cells		**Current Fuel Costs**		
Departure Fuel Price $/gal	$3.03	DFSP, JP-8	$3.03	1-Oct-10
Tankerred Fuel Load lbs	28346.80	Jet A (Into-Plane)	$3.46	1-Oct-10
Purchase Cost (departure)	$12,705.74	Jet A (Non Contract Source at Airport)	$4.27	1-Oct-10
Planned Flight Time Hours	8.1	NATO	$6.50	1-Oct-10
Cost to Carry lbs	10102.80			
Aircraft Cost to Carry	0.044	**Cost to Carry**		
Destination Fuel Price $/gal	$6.50	C-17	4.40%	0.0440
Tankered Fuel Remaining lbs	18244.00	C-5	5.67%	0.0567
Purchase Cost (destination)	$17,542.31	KC-135	4.97%	0.0497
Fuel Purchase Ratio	0.724	KC-10	4.47%	0.0447
Fuel Cost Ratio	0.466	C-130	3.00%	0.0300
Tankering Index	1.417			
Cost Avoidance/Savings (5% mx cost)	$4,594.74	Negative Means Money Lost		
Cost Avoidance/Savings (1% mx cost)	$4,788.20	Negative Means Money Lost		

Figure 7: Model Example

Within the model and historical analysis, multiple calculations are computed. Below is a description of the calculations required to meet the goals of the research. With the equations, there is a brief description of why the specific calculation was used if the description is warranted.

Purchase Cost:

$$Purchase\ Cost = \left\{\frac{Amount\ of\ Fuel\ Lbs}{6.76}\right\} \times Price\ of\ Fuel \quad (1)$$

Cost to Carry:

$$Cost\ to\ Carry = (Tankered\ Fuel\ Load \times Aircraft\ Cost\ to\ Carry) \times Planned\ Flight\ Time$$

(2)

Cost to carry can be calculated multiple ways. Throughout the research period different research used different methods to arrive at similar solutions. This equation is a conservative estimate using aircraft cost to carry numbers provided by Cyintech data which tends to result in higher fuel burns and limits savings (meaning actual results should exceed this value). This equation is also simple, taking into account both climb and cruise penalties and averaging the penalties for heavier, medium, and lighter weight aircraft as identified by Cyintech. Equation 2 does not consider any maintenance costs associated with tankering- this is accounted for later. "If fuel is tankered, the airplane will land at a higher weight than normal, causing greater wear on the brakes, tires, and reversers. Some operators add five percent to the fuel differential in calculating break-even fuel tankering costs. Others add a flat 10 cents per gallon in their cost trades" (Boeing, 1997:3). On the other hand, Continental Airlines does not apply any penalty. Continental believes that the plane is being flown within its operational limits and therefore no penalty is required.

Cost Avoidance:

$$Cost\ Avoidance\ = Purchase\ Cost\ Departure - Purchase\ Cost\ Destination\ \times\ 95\% \quad (3)$$

Cost avoidance (Equation 3) represents the amount of money saved by tanking fuel from the departure field to the destination. Negative numbers indicate that tankering fuel will cost additional money. The amount saved is reduced by either 5% or 1%. This is the range of variables which commercial companies use to account for maintenance costs as described above. This would account for the extra stress on the aircraft for the additional weight carried and the extra wear and tear on engines (running at higher power settings) and landing gear, brakes, and tires which are used more quickly because of the higher landing weights.

Fuel Purchase Ratio:

$$Fuel\ Purchase\ Ratio = \left\{\frac{Fuel\ Purchase\ Cost\ (Departure)}{Fuel\ Purchase\ Cost\ (Destination)}\right\} \tag{4}$$

Fuel Cost Ratio:

$$Fuel\ Cost\ Ratio = \left\{\frac{Fuel\ Cost\ (Departure)}{Fuel\ Cost\ (Destination)}\right\} \tag{5}$$

The information received from the fuel purchase ratio is more informative than that of the fuel cost ratio because it incorporates the flight time and cost to carry into the ratio. As pointed out in table 7 below, the fuel purchase ratio is the ultimate ratio that will define if the tankered flight will save money. The fuel cost ratio is less informative and would only be helpful in data or trend analysis; it is possible to ignore this ratio completely.

Tankering Index:

$$Tankering\ Index = (1 + Aircraft\ Cost\ to\ Carry)^{Planned\ Time\ of\ Flig\square t} \tag{6}$$

Table 7: Example Calculation of Fuel Purchase Ratio, Fuel Cost Ratio, and Tankering Index

Number	Departure Price	Destination Price	Fuel Cost Ratio	Length of Flight	Fuel Purchase Ratio	Tankering Index	Savings with 1% MX Cost
1	$3.03	$3.46	.867	4.0	1.063	1.188	-$264.73
2	$3.03	$3.46	.867	2.0	.960	1.09	$185.68
3	$3.03	$6.50	.466	4.0	5.66	1.188	$3,440.83
4	$3.03	$6.50	.466	2.0	.511	1.09	$4,286.98
5	$4.27	$3.03	1.409	4.0	1.71	1.188	-$2,623.20
6	$4.27	$3.03	1.409	2.0	1.545	1.090	-$2,228.76

(All calculations are based on C-17 with a cost to carry of 4.4% and 10,000 lbs of fuel tankered)

The ratios and tankering index are calculations which allow for a simple and quick understanding of the factors that will affect a given flight. If the ratio values are low, potential for cost savings are high. Likewise, if either the fuel cost ratio or fuel purchase ratio is near, equal to, or over 1.0 (as seen in Table 7 calculations 1, 5, and 6) tankering should not be used. It is possible to use these ratios as a decision point on whether or not to tanker on a given mission. Another decision point is to use a minimal savings of $100 per flight; as an example, if the flight does not save $100 on the flight, tankering would not be used. The justification is that the additional wear and tear on the aircraft caused by tankering is not worth a relatively minimal cost savings. Other users believe that every bit of savings adds up and the $50 saved from 10 flights every day adds up to $15,000 a month (FedEx Team, 2010; Dubner, 2010).

Part IV

RESULTS AND ANALYSIS

The historical data results are found in Attachment D, and the full calculations can be obtained by contacting the author or Dr. Alan Johnson at AFIT. If requested, the full spreadsheet of calculation may be obtained.

Starting with the 3,814 missions, and examining 2,029 missions, it was determined that 377 flights would have saved money by tankering fuel. This is only 10% of the total missions flown during the time period. An exact savings figure is difficult to obtain because of the assumptions in the report. A savings of $5.853 million was the potential cost savings according to the entire historical review for the two week period. Analysis was taken a step further, by matching follow-on missions (the next mission that was flown after the tankering leg) to 333 of the tankering mission.

Focusing on the 333 missions, potential cost avoidance was calculated at $5.393 million. The data was then recalculated allowing for the potential cost avoidance based on the lower tanker quantity of, the amount of fuel planned for the next flight or the maximum amount capable of being tankered. This recalculation only took into account the immediate next flight and not flights after that. If a flight flew from a $3.03 station to a $6.50 station then another $6.50 station and finally to a $3.03 station, the savings were only calculated for that first flight between the two $6.50 stations. This scenario occurred multiple times with the flight between $6.50 stations being less than an hour followed by a mission to a $3.03 station that would be 3 or 4 hours. Not taking this into account simplified the calculations but allows for an opportunity to miss large potential cost avoidance. This was mitigated by using the planned fuel loads on that first leg after the tankering leg. Planned fuel loads on some flights were higher than needed for the next immediate flight, making the calculation of potential cost avoidance higher than it really was. Using this method, potential cost avoidance for the 333 missions during the time period totaled $4.262 million. It is important to point out that 183 of those missions were involved in tankering operations in and out of the three stations that had fuel priced at $6.50 a gallon. Those 183 missions accounted for $3.889 million of the cost avoidance. The $373,375 in cost avoidance during the time frame by the remaining flights would account for $9.708 million in cost avoidance for the year. If the $4.262 million is used as the base cost avoidance number during the two week time frame, yearly savings could reach nearly $111 million.

These annual numbers do not account for the 44 missions because follow-on mission information was not available. The maximum yearly cost avoidance on those missions was calculated at approximately $12 million. Calculations also do not take into account the air refueling flights that operated during this time period. A majority of our refueling aircraft are fueled at DoD fields and at the lowest price point available. When that fuel is transferred into a receiver, preventing that receiver from landing or refueling at a high price point field, additional savings can be achieved. One final assumption that was not taken into account in the calculation that can dramatically affect the potential cost avoidance numbers is the actual field data. It is possible that the amount of fuel tankered in the calculations will make a plane too heavy to take off or land at an airfield due to the amount of runway available or atmospheric conditions. It is impossible to correctly calculate this as the airfield and atmospheric variables change based on the planning factors input. Greater potential cost savings will be capable when the temperatures are colder because aircraft can carry more weight (or more tankered fuel) than when temperatures are higher.

Part V

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Fuel cost represents an enormous part of all airline budgets and the AMC, Air Force and DoD's budget. "Fuel always constrains aircraft operations, not only in terms of range and capacity but also because of its contribution to total operating cost. Airline fuel costs can contribute up to half of the operating expense for larger, long-range transports" (Saglam, 2009:14). Reducing this cost is imperative to AMC mission success. The cost savings/avoidance would allow for better planning systems, other fuel saving initiatives (such as winglets) and new aircraft that would allow for further savings.

Recommended Rules for an AMC Tankering Program

It is imperative that AMC initiate a fuel tankering program. The most effective way to do this is to purchase a new flight planning software suite. It was outside the scope of this paper to recommend or further research new flight planning software. Tankering calculation capability is just one of many variables that should be designed in the new software suite. AMC is currently looking into the acquisition of a new flight planning system. Until the opportunity to purchase a new flight planning system presents itself in the budget, using the model in this paper will be able to capture some savings through additional steps accomplished by the flight planners. While this is not ideal, the high reward (upwards of possibly $111 million) makes it necessary.

The first rule to tankering is to never turn away cargo or passengers in order to tanker for cost savings. Following this rule will allow for the fewest number of missions possible, while saving the most money. When cargo delivery time requirements dictate that the flight goes less than full, the practice of fuel tankering can and will save money. The following recommendations should be the framework which guides the creation of such a program.

The second rule to tankering is to avoid planning or flying to airfields that have a higher fuel cost than the DoD standard price. While mission requirements sometime require flight into airfield that have fuel at higher prices, this should be minimized to the maximum extent possible. If a mission can be delayed by one hour (to avoid quiet hours) and then allowed to fly into and land at a DoD location, the fuel cost savings can be great.

- *Plan missions backwards: final sortie first and first sortie last.* When planning tankering fuel manually (without an upgraded flight planning software), it is imperative to plan the second and subsequent flights prior to planning the first flight. This will prevent tankering too much fuel creating a defuel or cargo/passenger rejection at the subsequent stops. Used by: all companies that tanker fuel, usually automatically done by the flight planning software program.
- *Do not tanker fuel beyond tank volume and/or mass capacity.* Consider limiting tankering to 1% less than capacity to prevent fuel leaks caused by venting during temperature swings. Used by: UPS.

- *Do not tanker to maximum take-off weight*. This will prevent exceeding max take-off weight when last minute cargo is added to the flight increasing the zero fuel weight. This buffer should be a fixed delta weight. Further study can be conducted to determine a more accurate amount, but the recommendation is 3000 lbs until greater fidelity can be gained to the cargo requirement then reduce the limit to 1000 lbs. This recommendation reduces the amount of tankered fuel limiting maximum savings but preventing delays or frustrated cargo. This recommendation can and should vary for each aircraft type/size. Used by: Atlas, UPS.

- *Do not tanker to Max Landing Weight in order to prevent holding*. Only tanker to 2-3% below aircraft max landing weight or a fixed delta weight such as 4,000 lbs of fuel on large aircraft and 2,000 lbs of fuel on smaller aircraft. This number should be reduced to 2,000 pounds and 1,000 pounds when a higher degree of precision is able to be achieved in the flight planning and fuel tracking. This allows for shorter routing, better than expected winds, and other unforeseen reductions in flight time as well as last minute increases in zero fuel weight. Used by: Atlas, UPS, Continental.

- *Do not tanker with maintenance issues* such as thrust reverser inoperative or weather issues such as a wet or icy runway or those with reported or forecast poor braking action. Use caution when tankering into a location with low temperatures, high relative humidity and/or precipitation (icy or snowy conditions). Used by: Atlas, UPS.

- *Do not tanker so that weight exceeds that of maximum weight limits by departure airport, specific to each aircraft and airport*. Runway length for take-off and landing, weight bearing capacities of runways, taxi ways, and ramps must all be calculated. Used by: all companies that tanker fuel, usually automatically done by the flight planning software program.

- *Do not tanker to high and hot airfields* where go around with an engine out may not be possible. Used by: UPS, Atlas.

- *Carefully consider not tankering on long flights (in excess of 5 to 6 hours).* Cost to Carry will be much more expensive and may dramatically limit aircraft performance (no step climbs). It may still be economically beneficial to tanker on long flights when the price difference is great. Weigh the risk-reward at the planning level. Used by: UPS.

- *The tankering calculations should be automated*. Calculations should be part of the flight planning system; it will be one of the first things abandoned when dispatchers become task saturated if this is a manual process. Used by: all companies that tanker fuel have an automated calculations build into their flight planning software.

- *If tankering is beneficial and the dispatcher decides not to tanker, justification should be annotated* (i.e. weather, maintenance issues). Used by: Atlas, Continental, UPS.

- *If dispatchers tanker when it is not profitable, justification should be annotated* (i.e. station fuel shortage, reduced ground time to meet ATC slot time, unreliable fuel source). Used by: Atlas, Continental, UPS.

- *Do not tanker fuel when other mission objectives are a higher priority.* It may be important to fuel at a higher priced location in order to accomplish international training (Building partnership capability) or infuse a region with economic aid.

Additional Recommendations

A few additional recommendations are worth pointing out based upon discussion amongst numerous evaluator and instructor pilots from all AMC platforms and through personal experience as a KC-10 pilot and C-130 evaluator and instructor pilot.

- AMC must ensure that current crews practice flying and discuss the characteristics of flying a heavier aircraft associated with tankering fuel. Crews should practice landing a heavier jet in the simulator or during real training and understand the dangers associated with it such as braking action, fast approach speed (leading to steeper glide-path), go around capabilities, maximum decent rates (certain aircraft) at heavyweight touchdown, and higher power settings in high-threat environments. These discussions and hands-on preparation can be augmented with the release of AMC Special Interest Items discussing the factors above as well as the consequences of flying a heavier aircraft. Points that should be focused on include: lower terrain clearance on take-off, slower climbs rates, lower cruise altitude, reduced stall recovery capability along with higher stall speed, higher approach speed, increased landing distance and increased tire and brake wear.

- The USAF and AMC need to consider writing fuel efficiency and/or tanker mandates or guidelines into the contracts with the civilian contract carriers. Contracts have been written where the commercial carrier will pay for the first $2 or $3 per gallon (the PEG price), then AMC will be responsible for the cost of fuel above that. This type of contract does not promote fuel or fiscal conservation because the carrier does not have incentives to conserve fuel or reduce fuel charges because their price is always a flat rate.

- AMC should adopt even more of an airline model for adding fuel to a mission. If the commercial pilot wants to add fuel, the pilot must call the dispatcher who must obtain approval; then the dispatcher would call POL to add the fuel. POL will not add fuel on the pilot's request, but they will only upon receipt of the request from the dispatcher. This will prevent pilots from adding extra fuel that is not needed while making POL the sole agency responsible for fuel distribution and tracking.
- Finally, AMC must continue to establish fuel conservation and cost reduction policies. These policies must be emphasized in initial training and upgrade programs. It must teach pilots and other crew member that they should not fly faster than necessary or planned and waste the extra fuel they carry. It will take time to instill a culture that promotes fuel conservation, and formalizing the policy and training to the standard is the first step. This must be further enforced through the evaluation process and tracked by the data collected after the completion of the mission.

<u>Implications</u>

This research could result in an institutional savings of millions of dollars for the USAF through the development of a new policy in how strategic and tactical aircraft missions are planned and operated. It provides an updated review of the tankering practice to the scholastic community since there is limited current research. Fuel cost savings at this level can allow for the recapitalization of the fleet or increased number of other fuel efficiency improvements which in turn will generate additional cost savings. "Each 1% improvement in fuel efficiency across the industry can lower fuel costs by $700 million per year" (International Air Transportation Association, 2010).

Future Operations Research Considerations

Tankering can be used to increase supply rates. Airfields with a limited aircraft Maximum On Ground (MOG) can handle more aircraft if the aircraft were on the field for a shorter amount of time. Tankering enough fuel to eliminate refueling requirements can increase the aircraft throughput dramatically. Compare tanker fuel options for either economic or operational fuel ferry scenarios, to include flying fuel into a forward operating base in order to sustain a base which has lost its ground or sea based logistics resupply routes.

Examine the maintenance cost of tankering fuel. What are the maintenance costs of flying the engine at a higher power setting and landing the plane at heavier weights causing greater wear and tear on landing gear, brakes and tires? Does tankering allow maintenance to turn planes quicker when they land with a reduction in the number of inspections required and will this allow for reduced manning? It is also possible to examine the possibilities and risks of moving to more concurrent servicing in order to take advantage of tankering by adding fuel at the last minute. If the plane is over-fueled too early and then requires defueling, and defueling is much slower than uploading fuel, do not fill the plane too early to prevent cargo from being loaded or fuel downloads. Further study can be done to calculate a more exact maintenance cost and one that is specific to each type aircraft.

Further research can also be done to determine the effect of tankering on the macro and micro fuel supply issues. Will tankering fuel reduce the requirement for fuel into certain areas to the point that it is not economically advantageous to do so, resulting in a fuel shortage? These macro and micro fuel supply issues may also lead to economic hardship for some fuel sellers. While unlikely because of the infrequency of tanker sorties, and the rare instances that the entire fuel loads are tankered, tankering may put fuel providers out of service, unintentionally. Within this study, it may also be helpful to define and show examples of where the military may want to pay more for fuel and services in order to bolster the economic stability of an area or to meet other military or political objectives of building partnership capacity.

There is a potential for cost savings, for the tanker and the receiver, in refueling missions but each flight must be looked at individually. As stated earlier, refueling aircraft normally fuel at military bases or DFSPs. When that fuel is transferred into a receiver, preventing that receiver from landing or refueling at a high price point field, there is a potential for savings. This low priced fuel may allow for some limited refueling missions that would create savings. While the cost saving scenario would be more complicated to prove, refueling missions would be critical if fuel supplies were unreliable or unavailable at a given airfield.

Additional savings may be possible at higher levels within the DoD by taking advantage of the price differences that DLA-ENERGY negotiate with our commercial fields, on the Jet A contracted standard price. As pointed out in Chapter 2, the price paid at different locations are averaged out to create the standard price. If an effort was made to fly to location with lower price points, it may allow the standard price to be reduced further saving AMC and the AF even more money.

Finally it may also be possible to determine if a similar tankering are possible for Army surface shipments with trucks and other vehicles as well as Army and Navy shipping vessels. The cost to carry on trucks and ships are low in comparison to aircraft, this may provide additional savings in transportation costs throughout the DoD. These charges need to be examined in concert with other port charges and fees that are associated with those shipping requirements.

Tankering fuel for cost avoidance is a tool that will save money for AMC, the Air Force and the DoD. It requires a small amount of extra work in the planning process with a focus on accuracy with regard to cargo and fuel loads. While the next generation of flight planning software should include this capability, the attached excel model will provide a tool that allows for this practice to be implemented immediately. This additional work and planning time can pay off with potential savings of $10 million to $110 million.

APPENDIX A: DFSP Location

Location	ICAO	Service	State	Country	MAJCOM	COCOM
AL ASAD	ORAA	ARMY	OCONUS	Iraq	AOR	CENTCOM
Al Dhafra UAE	OMAM	AF	OCONUS	United Arab Emirates	AFCENT	CENTCOM
Al Udeid Qatar	OTBH	AF	OCONUS	Qatar	AFCENT	CENTCOM
ALI AL SALEM AB	OKAS	AF	OCONUS	Kuwait	AFCENT	CENTCOM
ANACONDA		ARMY	OCONUS	Iraq	AOR	CENTCOM
Bagdad IAP	ORBU	AF	OCONUS	Iraq	AFCENT	CENTCOM
BAGRAM AIR BASE	OAIX	ARMY	OCONUS	Afghanistan	AOR	CENTCOM
Balad AB	ORBD	AF	OCONUS	Iraq	AFCENT	CENTCOM
CAMP BUEHRING		ARMY	OCONUS	Kuwait	AOR	CENTCOM
CAMP DIAMONDBACK (MOSUL)	ORBM	ARMY	OCONUS	Iraq	AOR	CENTCOM
CAMP VICTORY (VBC)		ARMY	OCONUS	Iraq	AOR	CENTCOM
CEDAR II		ARMY	OCONUS	Iraq	AOR	CENTCOM
Curacao		AF	OCONUS	Bahamas	ACC	CENTCOM
DFSP Fujairah		DESC	OCONUS	United Arab Emirates	NULL	CENTCOM
DFSP KABUL NAT	OAKN	DESC	OCONUS	Afghanistan	NULL	CENTCOM
DFSP Qatar		DESC	OCONUS	Qatar	NULL	CENTCOM
DFSP Seeb Oman	OOMS	AF	OCONUS	Oman	NULL	CENTCOM
DFSP Sitra	OBBI	DESC	OCONUS	Bahrain	NULL	CENTCOM
DFSP Star Jabel Ali		DESC	OCONUS	United Arab Emirates	NULL	CENTCOM
Kabul	OAKN	DESC	OCONUS	Afghanistan	NULL	CENTCOM
Kirkuk AB Iraq	ORKK	AF	OCONUS	Iraq	AFCENT	CENTCOM
KUWAIT TRUCK FILLSTA		ARMY	OCONUS	Kuwait	AOR	CENTCOM
Manas AFB	UAFM	AF	OCONUS	Krygikistan	AFCENT	CENTCOM
Masirah		AF	OCONUS	Oman	NULL	CENTCOM
Tallil Air Base	ORTL	AF	OCONUS	Iraq	AFCENT	CENTCOM
Thumrait	OOTH	AF	OCONUS	Oman	NULL	CENTCOM
Akrotiri Cyprus	LCRA	AF	OCONUS	Cyprus	USAFE	EUCOM
ANSBACH		ARMY	OCONUS	Germany	USAREUR	EUCOM
Aviano AB	LIPA	AF	OCONUS	Italy	USAFE	EUCOM
BARTON BARRACKS		ARMY	OCONUS	Germany	IMCOM	EUCOM
BAUHOLDER TMP		ARMY	OCONUS	Germany	IMCOM	EUCOM
CAMP DARBY		ARMY	OCONUS	Germany	IMCOM	EUCOM
Camp Lemonier		NAVY	OCONUS	Djibouti	NULL	EUCOM
Chievres Belgium		AF	OCONUS	Belgium	USAFE	EUCOM
COLEMAN BARRECKS		ARMY	OCONUS	Germany	IMCOM	EUCOM

COLEMANTK6		ARMY	OCONUS	Germany	USAREUR	EUCOM
CONNBKSSTA		ARMY	OCONUS	Germany	IMCOM	EUCOM
DFSP Athens		DESC	OCONUS	Greece	NULL	EUCOM
DFSP Augusta		DESC	OCONUS	Greece	NULL	EUCOM
DFSP CENT EURO PL (CEPS)		DESC	OCONUS	Italy	NULL	EUCOM
DFSP Djibouti	HDAM	DESC	OCONUS	Djibouti	NULL	EUCOM
DFSP Gaeta		DESC	OCONUS	Italy	NULL	EUCOM
DFSP Rota	LERT	NAVY	OCONUS	Spain	NULL	EUCOM
DFSP Souda Bay	LGSA	DESC	OCONUS	Crete	NULL	EUCOM
DFSP Speyer		DESC	OCONUS	Germany	NULL	EUCOM
GARMISCH TMP		ARMY	OCONUS	Germany	IMCOM	EUCOM
GERMERSHEIM		ARMY	OCONUS	Germany	IMCOM	EUCOM
GRAFNWOEHR		ARMY	OCONUS	Germany	IMCOM	EUCOM
HEIDELBERG		ARMY	OCONUS	Germany	IMCOM	EUCOM
HOHENSFELS		ARMY	OCONUS	Germany	IMCOM	EUCOM
ILLESHMAAF		ARMY	OCONUS	Germany	IMCOM	EUCOM
Incirlik AB	LTAG	AF	OCONUS	Turkey	USAFE	EUCOM
KAISERSLAUGHTEN		ARMY	OCONUS	Germany	IMCOM	EUCOM
KELLY BARRECKS TMP		ARMY	OCONUS	Germany	IMCOM	EUCOM
KIC FUEL STATION		ARMY	OCONUS	Germany	IMCOM	EUCOM
Lajes Field	LPLA	AF	OCONUS	Azores	USAFE	EUCOM
LANDSTUHL		ARMY	OCONUS	Germany	IMCOM	EUCOM
MAINZ-KASTEL TMP (GE)		ARMY	OCONUS	Germany	IMCOM	EUCOM
MIESAU, GE		ARMY	OCONUS	Germany	IMCOM	EUCOM
Moron AB	LEMO	AF	OCONUS	Spain	USAFE	EUCOM
NAS Sigonella	LICZ	NAVY	OCONUS	Sicily	NULL	EUCOM
Navsuppact Naples	LIRN	NAVY	OCONUS	Italy	NULL	EUCOM
NIPS		DESC	OCONUS	Italy	NULL	EUCOM
NSF Souda Bay	LGSA	NAVY	OCONUS	Crete	NULL	EUCOM
PANZER KASERNE		ARMY	OCONUS	Germany	IMCOM	EUCOM
PIRMASENS TMP		ARMY	OCONUS	Germany	IMCOM	EUCOM
RAF Alconbury	EGWZ	AF	OCONUS	United Kingdom	USAFE	EUCOM
RAF CROUGHTON		AF	OCONUS	United Kingdom	USAFE	EUCOM
RAF Fairford	EGVA	AF	OCONUS	United Kingdom	USAFE	EUCOM
RAF LAKENHEATH, ENGL	EGUL	AF	OCONUS	United Kingdom	USAFE	EUCOM
RAF MENWITH HILLS		AF	OCONUS	United Kingdom	USAFE	EUCOM
RAF Mildenhall	EGUN	AF	OCONUS	United Kingdom	USAFE	EUCOM
Ramstein AB	ETAR	AF	OCONUS	Germany	USAFE	EUCOM

ROB FUEL STATION		ARMY	OCONUS	Germany	IMCOM	EUCOM
Sembach Fuel Point		ARMY	OCONUS	Germany	IMCOM	EUCOM
SPANGDAHLEM AB GM	ETAD	AF	OCONUS	Germany	USAFE	EUCOM
Spanish Pipeline		DESC	OCONUS	Spain	NULL	EUCOM
SPINELITMP		ARMY	OCONUS	Germany	IMCOM	EUCOM
SULLIVAN BARRACKS		ARMY	OCONUS	Germany	IMCOM	EUCOM
Thule AB	BGTL	AF	OCONUS	Greenland	AFSPC	EUCOM
TNP		DESC	OCONUS	Turkey	NULL	EUCOM
TOMPKINS BARRACKS		ARMY	OCONUS	Germany	IMCOM	EUCOM
UK Pipeline		DESC	OCONUS	United Kingdom	NULL	EUCOM
VICENZAPOL		ARMY	OCONUS	Germany	IMCOM	EUCOM
VILSECKPOL		ARMY	OCONUS	Germany	IMCOM	EUCOM
WARNER BARRACKS		ARMY	OCONUS	Germany	IMCOM	EUCOM
WIESBADNOP		ARMY	OCONUS	Germany	USAREUR	EUCOM
AASF 1 Phoenix		ARMY	Arizona	US	NGB	NORTHCOM
AASF 1, Salem		ARMY	Oregon	US	NGB	NORTHCOM
AASF Grand Ledge		ARMY	Michigan	US	NGB	NORTHCOM
AASF ISLIP		ARMY	New York	US	NGB	NORTHCOM
AASF Latham		ARMY	New York	US	NGB	NORTHCOM
AASF Mather		ARMY	California	US	NGB	NORTHCOM
AASF NORTH CANTON		ARMY	Ohio	US	NGB	NORTHCOM
AASF Rochester		ARMY	New York	US	NGB	NORTHCOM
AASF ST Paul		ARMY	Minnesota	US	NGB	NORTHCOM
AASF West Jordan		ARMY	Utah	US	NGB	NORTHCOM
AASF2 Marana		ARMY	Arizona	US	NGB	NORTHCOM
AASF2, Pendleton		ARMY	Oregon	US	NGB	NORTHCOM
Aberdeen Proving		ARMY	Maryland	US	IMCOM	NORTHCOM
ACU-5		NAVY	California	US	NULL	NORTHCOM
Alpena ANG		AF	Michigan	US	ANG	NORTHCOM
ALTUS AFB	KAXS	AF	Oklahoma	US	AETC	NORTHCOM
Andrews AFB	KADW	AF	Maryland	US	DRU	NORTHCOM
Andrews ANG	KADW	AF	Maryland	US	ANG	NORTHCOM
Andros Island		NAVY	OCONUS	Bahamas	NULL	NORTHCOM
Anniston Army Depot		ARMY	Alabama	US	AMC	NORTHCOM
Arnold Engineering	KAYX	AF	Tennessee	US	AFMC	NORTHCOM
Atlantic City IAP	KACY	AF	New Jersey	US	ANG	NORTHCOM
AVCRAD Springfield		ARMY	Missouri	US	NGB	NORTHCOM
Bangor ANG	KBGR	AF	Maine	US	ANG	NORTHCOM
Barksdale AFB	KBAD	AF	Louisiana	US	AFGSC	NORTHCOM
Barnes ANG	KBAF	AF	Massachusetts	US	ANG	NORTHCOM

Battle Creek ANG	KAZO	AF	Michigan	US	ANG	NORTHCOM
Beale AFB	KBAB	AF	California	US	ACC	NORTHCOM
Beauregard		ARMY	Louisiana	US	NGB	NORTHCOM
Bellechase		NAVY	Louisiana	US	NULL	NORTHCOM
Birmingham ANG	KBHM	AF	Alabama	US	ANG	NORTHCOM
Blue Grass Army Depot		ARMY	Kentucky	US	AMC	NORTHCOM
Boone AASF#1		ARMY	Iowa	US	NGB	NORTHCOM
Bradley Field ANG	KBDL	AF	Connecticut	US	ANG	NORTHCOM
BREMEN GA, ST SERVICES		DESC	Georgia	US	NULL	NORTHCOM
BUCKEYE 000054 (PA)		DESC	Pennsylvania	US	NULL	NORTHCOM
BUCKEYE Ohio		DESC	Pennsylvania	US	NULL	NORTHCOM
BUCKEYE PL CT		DESC	Pennsylvania	US	NULL	NORTHCOM
Buckley AFB	KBKF	AF	Colorado	US	AFSPC	NORTHCOM
Buckley ANG Base	KBKF	AF	Colorado	US	ANG	NORTHCOM
Burlington ANG	KBTV	AF	Vermont	US	ANG	NORTHCOM
Byrd Field AASF		ARMY	Virginia	US	NGB	NORTHCOM
Calnev Pipeline Co		DESC	Nevada	US	NULL	NORTHCOM
Camp Atterbury		ARMY	Indiana	US	NGB	NORTHCOM
Camp Blanding		ARMY	Florida	US	NGB	NORTHCOM
Camp Bullis		ARMY	Texas	US	IMCOM	NORTHCOM
Camp Clark		ARMY	Missouri	US	NGB	NORTHCOM
Camp Crowder TNG Site		ARMY	Missouri	US	NGB	NORTHCOM
Camp Dodge		ARMY	Iowa	US	NGB	NORTHCOM
Camp Grayling		ARMY	Michigan	US	NGB	NORTHCOM
Camp Gruber		ARMY	Oklahoma	US	NGB	NORTHCOM
Camp Guernsey		ARMY	Wyoming	US	NGB	NORTHCOM
Camp Keyes		ARMY	Maine	US	NGB	NORTHCOM
Camp LeJune		NAVY	North Carolina	US	NULL	NORTHCOM
Camp McCain		ARMY	Mississippi	US	NGB	NORTHCOM
Camp McKall		ARMY	North Carolina	US	IMCOM	NORTHCOM
Camp Navajo		ARMY	Arizona	US	NGB	NORTHCOM
Camp Pendleton		NAVY	California	US	NULL	NORTHCOM
Camp Pendleton Gas Station		NAVY	California	US	NULL	NORTHCOM
Camp Perry		ARMY	Ohio	US	NGB	NORTHCOM
Camp Rilea		ARMY	Oregon	US	NGB	NORTHCOM
CAMP RILEY		ARMY	Minnesota	US	NGB	NORTHCOM
Camp Ripley		ARMY	Minnesota	US	NGB	NORTHCOM
Camp Roberts		ARMY	California	US	NGB	NORTHCOM
Camp Robinson		ARMY	Arkansas	US	NGB	NORTHCOM
Camp Santiago		ARMY	OCONUS	Puerto Rico	NGB	NORTHCOM

Camp Shelby		ARMY	Mississippi	US	NGB	NORTHCOM
Camp Withycombe		ARMY	Oregon	US	NGB	NORTHCOM
Cannon AFB	KCVS	AF	New Mexico	US	AFSOC	NORTHCOM
Carson Terminal		DESC	California	US	NULL	NORTHCOM
Carswell AFB		AF	Texas	US	AFRC	NORTHCOM
Carswell Field ANG		AF	Texas	US	ANG	NORTHCOM
CBC Gulfport		NAVY	Mississippi	US	NULL	NORTHCOM
Channel Islands ANG		AF	California	US	ANG	NORTHCOM
Charleston AFB	KCHS	AF	South Carolina	US	AMC	NORTHCOM
Charleston WV Yeager Field	KCRW	AF	West Virginia	US	ANG	NORTHCOM
Cheyenne APRT ANG	KCYS	AF	Wyoming	US	ANG	NORTHCOM
China Lake		NAVY	California	US	NULL	NORTHCOM
Colonial PL CO		DESC	Texas	US	NULL	NORTHCOM
Columbus AFB	KCBM	AF	Mississippi	US	AETC	NORTHCOM
Columbus PL		DESC	Mississippi	US	NULL	NORTHCOM
Concord AAF		ARMY	New Hampshire	US	NGB	NORTHCOM
CPDAWSON		ARMY	West Virginia	US	NGB	NORTHCOM
Creech AFB		AF	Nevada	US	ACC	NORTHCOM
Cusik Survival School		AF	Washington	US	AETC	NORTHCOM
Dannelly ANG		AF	Alabama	US	ANG	NORTHCOM
Davenport ARNG		ARMY	Iowa	US	NGB	NORTHCOM
Davis Monthan AFB	KDMA	AF	Arizona	US	ACC	NORTHCOM
Davision Army Airfield		ARMY	Virginia	US	IMCOM	NORTHCOM
Des Moines ANG	KDSM	AF	Iowa	US	ANG	NORTHCOM
DFSP 29 Palms		DESC	California	US	NULL	NORTHCOM
DFSP Alamogordo		DESC	New Mexico	US	NULL	NORTHCOM
DFSP Annacostia		DESC	Maryland	US	NULL	NORTHCOM
DFSP BOBO		DESC	FLOATING	US	NULL	NORTHCOM
DFSP Boston		DESC	Massachusetts	US	NULL	NORTHCOM
DFSP BUTTON		DESC	FLOATING	US	NULL	NORTHCOM
DFSP Carteret		DESC	New Jersey	US	NULL	NORTHCOM
DFSP Charleston		DESC	South Carolina	US	NULL	NORTHCOM
DFSP Craney Island		DESC	Virginia	US	NULL	NORTHCOM
DFSP Ells Jet		DESC	South Dakota	US	NULL	NORTHCOM
DFSP Explorer		DESC	Oklahoma	US	NULL	NORTHCOM
DFSP Fort Bragg		ARMY	North Carolina	US	IMCOM	NORTHCOM
DFSP Fort Gordon		ARMY	Georgia	US	IMCOM	NORTHCOM
DFSP Fort Stewart		ARMY	Georgia	US	IMCOM	NORTHCOM
DFSP Guantanamo Bay	MUGM	NAVY	OCONUS	Cuba	NULL	NORTHCOM
DFSP Houston		DESC	Texas	US	NULL	NORTHCOM

DFSP Hunter AAF	KSVN	ARMY	Georgia	US	IMCOM	NORTHCOM
DFSP Indianapolis		DESC	Indiana	US	NULL	NORTHCOM
DFSP Jacksonville		NAVY	Florida	US	NULL	NORTHCOM
DFSP Jacksonville NJ		DESC	New Jersey	US	NULL	NORTHCOM
DFSP KOCAK		DESC	FLOATING	US	NULL	NORTHCOM
DFSP Lebanon		DESC	Ohio	US	NULL	NORTHCOM
DFSP LOPEZ		DESC	FLOATING	US	NULL	NORTHCOM
DFSP Ludlow		DESC	Massachusetts	US	NULL	NORTHCOM
DFSP LUMMUS		DESC	FLOATING	US	NULL	NORTHCOM
DFSP Macon		DESC	Georgia	US	NULL	NORTHCOM
DFSP Mayport		NAVY	Florida	US	NULL	NORTHCOM
DFSP Montgomery		DESC	Alabama	US	NULL	NORTHCOM
DFSP Moundville		DESC	Alabama	US	NULL	NORTHCOM
DFSP New Haven		DESC	Connecticut	US	NULL	NORTHCOM
DFSP NOVI		DESC	Michigan	US	NULL	NORTHCOM
DFSP NW Chevron Pipeline		DESC	California	US	NULL	NORTHCOM
DFSP OBREGON		DESC	FLOATING	US	NULL	NORTHCOM
DFSP Olathe		DESC	Kansas	US	NULL	NORTHCOM
DFSP Omaha		DESC	Nebraska	US	NULL	NORTHCOM
DFSP Pasco		DESC	Washington	US	NULL	NORTHCOM
DFSP Pittsburg		DESC	Pennsylvania	US	NULL	NORTHCOM
DFSP PLESS		DESC	FLOATING	US	NULL	NORTHCOM
DFSP Port Everglades		DESC	Florida	US	NULL	NORTHCOM
DFSP Port Mahon		DESC	NULL	US	NULL	NORTHCOM
DFSP Portland ME		DESC	Maine	US	NULL	NORTHCOM
DFSP Rodman		DESC	OCONUS	Panama	NULL	NORTHCOM
DFSP Salt Lake City		DESC	Utah	US	NULL	NORTHCOM
DFSP San Pedro		DESC	California	US	NULL	NORTHCOM
DFSP Seabrook		DESC	Texas	US	NULL	NORTHCOM
DFSP Selby		DESC	California	US	NULL	NORTHCOM
DFSP Selma		DESC	North Carolina	US	NULL	NORTHCOM
DFSP Sewells Point		DESC	Virginia	US	NULL	NORTHCOM
DFSP Standard Transpipe		DESC	North Carolina	US	NULL	NORTHCOM
DFSP Tampa		DESC	Florida	US	NULL	NORTHCOM
DFSP Tulsa		DESC	Oklahoma	US	NULL	NORTHCOM
DFSP Verona		DESC	New York	US	NULL	NORTHCOM
DFSP Watson		DESC	California	US	NULL	NORTHCOM
DFSP WILLIAMS		DESC	FLOATING	US	NULL	NORTHCOM
DFSP Yorktown		DESC	Virginia	US	NULL	NORTHCOM
DFSPBaltimore		DESC	Maryland	US	NULL	NORTHCOM

Dobbins ARB	KMGE	AF	Georgia	US	AFRC	NORTHCOM
Douglas ANG	KCLT	AF	North Carolina	US	ANG	NORTHCOM
Dover AFB	KDOV	AF	Delaware	US	AMC	NORTHCOM
DSC Philadelphia		DESC	Pennsylvania	US	NULL	NORTHCOM
DSCC Columbus		DESC	Ohio	US	NULL	NORTHCOM
Dugway Proving Ground		ARMY	Utah	US	IMCOM	NORTHCOM
Duluth ANG	KDLH	AF	Minnesota	US	ANG	NORTHCOM
Dyess AFB	KDYS	AF	Texas	US	ACC	NORTHCOM
Edwards AFB	KEDW	AF	California	US	AFMC	NORTHCOM
Eglin AFB	KVPS	AF	Florida	US	AFMC	NORTHCOM
Ellington Field ANG	KEDF	AF	Texas	US	ANG	NORTHCOM
ELLSWORTH AFB	KRCA	AF	South Dakota	US	ACC	NORTHCOM
Fairchild AFB		AF	Washington	US	AMC	NORTHCOM
Fairchild ANG	KSKA	AF	Washington	US	ANG	NORTHCOM
FE Warren AFB	KSKA	AF	Colorado	US	AFGSC	NORTHCOM
Forbes Field ANG	KFOF	AF	Kansas	US	ANG	NORTHCOM
Fort AP Hill		ARMY	Virginia	US	IMCOM	NORTHCOM
Fort Belvoir		ARMY	Virginia	US	IMCOM	NORTHCOM
Fort Benning	KLSF	ARMY	Georgia	US	IMCOM	NORTHCOM
Fort Bliss		ARMY	Texas	US	IMCOM	NORTHCOM
Fort Campbell 1	KHOP	ARMY	Kentucky	US	IMCOM	NORTHCOM
Fort Campbell 2	KHOP	ARMY	Kentucky	US	IMCOM	NORTHCOM
Fort Carson		ARMY	Colorado	US	IMCOM	NORTHCOM
Fort Custer		ARMY	Michigan	US	NGB	NORTHCOM
Fort Dix	KWRI	ARMY	New Jersey	US	IMCOM	NORTHCOM
Fort Drum	KGTB	ARMY	New York	US	IMCOM	NORTHCOM
Fort Eustis		ARMY	Virginia	US	IMCOM	NORTHCOM
Fort Hood	KGRK	ARMY	Texas	US	IMCOM	NORTHCOM
Fort Huachuca		ARMY	Arizona	US	IMCOM	NORTHCOM
Fort Hunter-Liggett		ARMY	California	US	NGB	NORTHCOM
Fort Indiantown Gap		ARMY	Pennsylvania	US	NGB	NORTHCOM
Fort Irwin		ARMY	California	US	IMCOM	NORTHCOM
Fort Jackson		ARMY	South Carolina	US	IMCOM	NORTHCOM
Fort Knox		ARMY	Kentucky	US	IMCOM	NORTHCOM
Fort Lee		ARMY	Virginia	US	IMCOM	NORTHCOM
Fort Leonardwood		ARMY	Missouri	US	IMCOM	NORTHCOM
Fort Lewis, Doss Aviation INC		ARMY	Washington	US	IMCOM	NORTHCOM
Fort McCoy		ARMY	Wisconsin	US	IMCOM	NORTHCOM
Fort McPherson-Gillem		ARMY	Georgia	US	IMCOM	NORTHCOM
Fort Meade		ARMY	Maryland	US	IMCOM	NORTHCOM

Fort Monmouth		ARMY	New Jersey	US	IMCOM	NORTHCOM
Fort Myer		ARMY	Virginia	US	IMCOM	NORTHCOM
Fort Pickett		ARMY	Virginia	US	NGB	NORTHCOM
Fort Riley		ARMY	Kansas	US	IMCOM	NORTHCOM
Fort Rucker		ARMY	Alabama	US	IMCOM	NORTHCOM
Fort Sam Houston		ARMY	Texas	US	IMCOM	NORTHCOM
Fort Sill		ARMY	Oklahoma	US	IMCOM	NORTHCOM
Fort Smith Map ANG	KSGL	AF	Arkansas	US	ANG	NORTHCOM
Fresno ANG	KFAT	AF	California	US	ANG	NORTHCOM
Ft Carson SuperStation		ARMY	Colorado	US	IMCOM	NORTHCOM
FT CHAFFEE		ARMY	Arkansas	US	NGB	NORTHCOM
FT LEAVENWORTH		ARMY	Kansas	US	IMCOM	NORTHCOM
FT WAYNE ANG	KFWA	AF	Indiana	US	ANG	NORTHCOM
Ft. Polk	KPOE	ARMY	Louisiana	US	IMCOM	NORTHCOM
Gen Mitchell Fld ANG	KMKE	AF	Wisconsin	US	ANG	NORTHCOM
Goodfellow AFB		AF	Texas	US	AETC	NORTHCOM
Gowen Field ANG	KBOI	AF	Idaho	US	ANG	NORTHCOM
GRAND FORKS	KGFK KRDR	AF	North Dakota	US	AMC	NORTHCOM
Great Falls	KGTF	AF	Montana	US	ANG	NORTHCOM
Greater Peoria ANGB	KPIA	AF	Illinois	US	ANG	NORTHCOM
Greater Pittsburg Afres	KPIT	AF	Pennsylvania	US	AFRC	NORTHCOM
Greater Pittsburg ANG	KPIT	AF	Pennsylvania	US	ANG	NORTHCOM
Grissom ARB	KGUS	AF	Indiana	US	AFRC	NORTHCOM
Gulfport ANG	KGPT	AF	Mississippi	US	ANG	NORTHCOM
Hancock Field	KSYR	AF	New York	US	ANG	NORTHCOM
Hanscom Field	KBED	AF	Massachusetts	US	AFMC	NORTHCOM
Harrisburg ANG	KMDT	AF	Pennsylvania	US	ANG	NORTHCOM
Hector Field	KFAR	AF	North Dakota	US	ANG	NORTHCOM
Hill AFB	KHIF	AF	Utah	US	AFMC	NORTHCOM
Holloman AFB	KHMN	AF	New Mexico	US	ACC	NORTHCOM
Holy Corp		DESC	Idaho	US	NULL	NORTHCOM
Homestead ARB	KHST	AF	Florida	US	AFRC	NORTHCOM
Hulman ANG		AF	Indiana	US	ANG	NORTHCOM
Hurlburt Field	KHRT	AF	Florida	US	AFSOC	NORTHCOM
Ike Skelton		ARMY	Missouri	US	NGB	NORTHCOM
Iowa ANG-185 ARW	KIOW	AF	Iowa	US	ANG	NORTHCOM
Jacksonville ANG	KJAX	AF	Florida	US	ANG	NORTHCOM
Joe Foss Field	KFSD	AF	South Dakota	US	ANG	NORTHCOM
Joint Base Ft. Story		DESC	Virginia	US	NULL	NORTHCOM
Joint Base Washington		ARMY	District of Columbia	US	NULL	NORTHCOM

KANEBPL		DESC	Kansas	US	NULL	NORTHCOM
Keesler AFB	KBIX	AF	Mississippi	US	AETC	NORTHCOM
Key Field	KMEL	AF	Mississippi	US	ANG	NORTHCOM
Key West Pipeline		DESC	Florida	US	NULL	NORTHCOM
Kinder Morgan-North		DESC	California	US	NULL	NORTHCOM
Kinder Morgan-West-South		DESC	California	US	NULL	NORTHCOM
Kingsley Field		AF	Oregon	US	ANG	NORTHCOM
Kinley Corp		DESC	Idaho	US	NULL	NORTHCOM
Kirtland AFB	KIKR	AF	New Mexico	US	AFMC	NORTHCOM
Kirtland ANG	KIKR	AF	New Mexico	US	ANG	NORTHCOM
LA ANG		AF	Louisiana	US	ANG	NORTHCOM
Lackland AFB	KSKF	AF	Texas	US	AETC	NORTHCOM
Lakesurst		NAVY	New Jersey	US	NULL	NORTHCOM
Lambert ANG	KSTL	AF	Missouri	US	ANG	NORTHCOM
Langley AFB	KLFI	AF	Virginia	US	ACC	NORTHCOM
Laughlin AFB	KDLF	AF	Texas	US	AETC	NORTHCOM
Letterkenny Army Depot		ARMY	Pennsylvania	US	AMC	NORTHCOM
LGIANELLA		DESC	FLOATING	US	NULL	NORTHCOM
Lincoln Map ANG	KAFK	AF	Nebraska	US	ANG	NORTHCOM
Little Rock AFB	KLRF	AF	Arkansas	US	AMC	NORTHCOM
Little Rock ANG	KLRF	AF	Arkansas	US	ANG	NORTHCOM
Lockhart Pipeline		DESC	Mississippi	US	NULL	NORTHCOM
Los Alamitos		ARMY	California	US	NGB	NORTHCOM
Luke AFB	KGBN	AF	Arizona	US	AETC	NORTHCOM
Macdill AFB	KMCF	AF	Florida	US	AMC	NORTHCOM
Malmstron AFB		AF	Montana	US	AFGSC	NORTHCOM
Mansfiled Lahm	KMFD	AF	Ohio	US	ANG	NORTHCOM
March ARB	KRIV	AF	California	US	AFRC	NORTHCOM
Martinsburg WV ANG	KMRB	AF	West Virginia	US	ANG	NORTHCOM
Maryland ANG		AF	Maryland	US	ANG	NORTHCOM
Maxwell AFB	KMXF	AF	Alabama	US	AETC	NORTHCOM
Mcalester Army Depot		ARMY	Oklahoma	US	AMC	NORTHCOM
MCAS Beaufort		NAVY	South Carolina	US	NULL	NORTHCOM
MCAS Cherry Point	KNKT	NAVY	North Carolina	US	NULL	NORTHCOM
MCAS New River		NAVY	North Carolina	US	NULL	NORTHCOM
MCAS Yuma	KYUM	NAVY	Arizona	US	NULL	NORTHCOM
MCB 29 Palms		NAVY	California	US	NULL	NORTHCOM
MCB Blount Island		NAVY	Florida	US	NULL	NORTHCOM
McChord AFB	KTCM	AF	Washington	US	AMC	NORTHCOM
McConnell AFB	KIAB	AF	Kansas	US	AMC	NORTHCOM

McEntire ANG	KMMT	AF	South Carolina	US	ANG	NORTHCOM
McGhee Tyson ANG	KTYS	AF	Tennessee	US	ANG	NORTHCOM
McGuire AFB	KWRI	AF	New Jersey	US	AMC	NORTHCOM
McGuire ANG	KWRI	AF	New Jersey	US	ANG	NORTHCOM
MCLB Albany		NAVY	Georgia	US	NULL	NORTHCOM
MCLB Barstow		NAVY	California	US	NULL	NORTHCOM
MCRD Parris Island		NAVY	South Carolina	US	NULL	NORTHCOM
MD ARNG		ARMY	Maryland	US	NGB	NORTHCOM
Memphis ANG	KMEM	AF	Tennessee	US	ANG	NORTHCOM
Mercer Field		ARMY	New Jersey	US	NGB	NORTHCOM
Minneapolis		AF	Minnesota	US	ANG	NORTHCOM
Minot AFB	KMIB	AF	North Dakota	US	AFGSC	NORTHCOM
Moffett Federal Airfield	KNUQ	DESC	California	US	NULL	NORTHCOM
Moffett Field ANG	KNQU	AF	California	US	ANG	NORTHCOM
Molinelli Field		ARMY	Alabama	US	IMCOM	NORTHCOM
Moody AFB	KVAD	AF	Georgia	US	ACC	NORTHCOM
Morrisville		ARMY	North Carolina	US	NGB	NORTHCOM
Mountain Home AFB	KMUO	AF	Idaho	US	ACC	NORTHCOM
MWTC Bridgeport		NAVY	California	US	NULL	NORTHCOM
NAB Little Creek		NAVY	Virginia	US	NULL	NORTHCOM
NAS Corpus Christi		NAVY	Texas	US	NULL	NORTHCOM
NAS El Centro		NAVY	California	US	NULL	NORTHCOM
NAS Ft Worth	KFWS	NAVY	Texas	US	NULL	NORTHCOM
NAS Jacksonville	KNIP	NAVY	Florida	US	NULL	NORTHCOM
NAS KEY West	KNQX	NAVY	Florida	US	NULL	NORTHCOM
NAS Kingsville		NAVY	Texas	US	NULL	NORTHCOM
NAS Lemoore	KNLC	NAVY	California	US	NULL	NORTHCOM
NAS Meridian		NAVY	Mississippi	US	NULL	NORTHCOM
NAS Miramar	KNKX	NAVY	California	US	NULL	NORTHCOM
NAS Norfolk	KNGU	NAVY	Virginia	US	NULL	NORTHCOM
NAS North Island	KNZY	NAVY	California	US	NULL	NORTHCOM
NAS Oceana	KNTU	NAVY	Virginia	US	NULL	NORTHCOM
NAS Patuxent River		NAVY	Maryland	US	NULL	NORTHCOM
NAS Pensacola		NAVY	Florida	US	NULL	NORTHCOM
NAS Whidby Island	KNUW	NAVY	Washington	US	NULL	NORTHCOM
NAS Whiting Field		NAVY	Florida	US	NULL	NORTHCOM
Nashville ANG	KBNA	AF	Tennessee	US	ANG	NORTHCOM
Naval Air Station Fallon		NAVY	Nevada	US	NULL	NORTHCOM
Naval Base Kitsap – Bangor		NAVY	Washington	US	NULL	NORTHCOM
Naval Base Ventura City	KNTD	NAVY	California	US	NULL	NORTHCOM

Naval Station Everett		NAVY	Washington	US	NULL	NORTHCOM
NAVSTA Mayport		NAVY	Florida	US	NULL	NORTHCOM
Navsubase New London		NAVY	Connecticut	US	NULL	NORTHCOM
Navsubbase Kings Bay		NAVY	Georgia	US	NULL	NORTHCOM
Nellis AFB	KLSV	AF	Nevada	US	ACC	NORTHCOM
New Castle ANG	KILG	AF	Delaware	US	ANG	NORTHCOM
Niagara Falls	KIAG	AF	New York	US	ANG	NORTHCOM
Niagara Falls	KIAD	AF	New York	US	AFRC	NORTHCOM
NS BREMERTON		NAVY	California	US	NULL	NORTHCOM
Offutt AFB	KOFF	AF	Nebraska	US	ACC	NORTHCOM
OMS Bangor		ARMY	Maine	US	NGB	NORTHCOM
Orange Grove		NAVY	Texas	US	NULL	NORTHCOM
Otis ANG	KFMH	AF	Massachusetts	US	ANG	NORTHCOM
Panama City		NAVY	Florida	US	NULL	NORTHCOM
Patrick AFB	KCOF	AF	Florida	US	AFSPC	NORTHCOM
Pease ANG	KPSM	AF	New Hampshire	US	ANG	NORTHCOM
PETERSON AFB	KCOS	AF	Colorado	US	AFSPC	NORTHCOM
Phillips AAF		ARMY	Maryland	US	IMCOM	NORTHCOM
Picatinny Arsenal		ARMY	New Jersey	US	IMCOM	NORTHCOM
Pine Bluff Arsenal		ARMY	Arkansas	US	AMC	NORTHCOM
Plant 42		AF	California	US	AFMC	NORTHCOM
Plantation Pipeline Co		DESC	Georgia	US	NULL	NORTHCOM
Point Loma		NAVY	California	US	NULL	NORTHCOM
Pope AFB	KPOB	AF	North Carolina	US	AMC	NORTHCOM
Portland IAP ANG	KPDX	AF	Oregon	US	ANG	NORTHCOM
Pueblo Chemical Depot		ARMY	Colorado	US	AMC	NORTHCOM
Puget Sound, Manchester		NAVY	Washington	US	NULL	NORTHCOM
PWC San Diego		NAVY	California	US	NULL	NORTHCOM
Quantico Marine Base	KNYG	NAVY	Virginia	US	NULL	NORTHCOM
Quonset Point ANG	KQQU	AF	Rhode Island	US	ANG	NORTHCOM
Randolph AFB	KRND	AF	Texas	US	AETC	NORTHCOM
Red River Army Depot		ARMY	Texas	US	AMC	NORTHCOM
RedHouse		ARMY	West Virginia	US	NGB	NORTHCOM
Redstone Arsenal	KHUA	ARMY	Alabama	US	IMCOM	NORTHCOM
Reno ANG	KRNO KRTS	AF	Nevada	US	ANG	NORTHCOM
Rickenbacker	KLCK	AF	Ohio	US	ANG	NORTHCOM
Robins AFB	KWRB	AF	Georgia	US	AFMC	NORTHCOM
Robins ANG	KWRB	AF	Georgia	US	ANG	NORTHCOM
Rock Island Arsenal		ARMY	Illinois	US	IMCOM	NORTHCOM
Rosencrans ANG		AF	Missouri	US	ANG	NORTHCOM

Salisbury		ARMY	North Carolina	US	NGB	NORTHCOM
Salt Lake City ANG	KSLC	AF	Utah	US	ANG	NORTHCOM
San Juan IAP		AF	OCONUS	Puerto Rico	ANG	NORTHCOM
San Luis Obispo		ARMY	California	US	NGB	NORTHCOM
Santa Fe Pacific Pipeline		DESC	Texas	US	NULL	NORTHCOM
Savannah ANG		AF	Georgia	US	ANG	NORTHCOM
Scotia		AF	New York	US	ANG	NORTHCOM
Scott AFB	KBLV	AF	Illinois	US	AMC	NORTHCOM
Scott ANG Chicago		AF	Illinois	US	ANG	NORTHCOM
Selfridge ANG	KMTC	AF	Michigan	US	ANG	NORTHCOM
Seymour Johnson	KGSB	AF	North Carolina	US	ACC	NORTHCOM
Shaw AFB	KSSC	AF	South Carolina	US	ACC	NORTHCOM
SHELBYVILLE	KSPS	ARMY	Indiana	US	NGB	NORTHCOM
Sheppard AFB		AF	Texas	US	AETC	NORTHCOM
Sierra Army Depot		ARMY	California	US	AMC	NORTHCOM
Simmons AAF		ARMY	North Carolina	US	IMCOM	NORTHCOM
Sky Harbor IAP ANG	KPHX	AF	Arizona	US	ANG	NORTHCOM
Soto Cano AB	MHSC	AF	OCONUS	Honduras	ACC	NORTHCOM
Springfield		AF	Ohio	US	ANG	NORTHCOM
Springfield Capital ANG		AF	Illinois	US	ANG	NORTHCOM
St. Paul	KMSP	AF	Minnesota	US	AFRC	NORTHCOM
Standiford Field		AF	Kentucky	US	ANG	NORTHCOM
Stewart		AF	New York	US	ANG	NORTHCOM
Stones Ranch		ARMY	Connecticut	US	NGB	NORTHCOM
TE Products TE CO		DESC	Texas	US	NULL	NORTHCOM
Teppco Jacksonville		DESC	Florida	US	NULL	NORTHCOM
Thompson Field		AF	Mississippi	US	ANG	NORTHCOM
Tinker AFB	KTIK	AF	Oklahoma	US	AFMC	NORTHCOM
Tobyhanna Army Depot		ARMY	Pennsylvania	US	AMC	NORTHCOM
Toledo	KTOL	AF	Ohio	US	ANG	NORTHCOM
Tonapah ANG	KTNX	AF	Nevada	US	ACC	NORTHCOM
Tooele Army Depot		ARMY	Utah	US	AMC	NORTHCOM
Travis AFB	KSUU	AF	California	US	AMC	NORTHCOM
Truax Field		AF	Wisconsin	US	ANG	NORTHCOM
Tucson IAP	KTUS	AF	Arizona	US	ANG	NORTHCOM
Tulsa IAP	KTUL	AF	Oklahoma	US	ANG	NORTHCOM
TX ANG, Kelly AFB	KSKF	AF	Texas	US	ANG	NORTHCOM
TX Eastern Products PL CO		DESC	Louisiana	US	NULL	NORTHCOM
Tyndall AFB	KPAM	AF	Florida	US	AETC	NORTHCOM
Umatilla Army Depot		ARMY	Oregon	US	AMC	NORTHCOM

USAF Academy	KAFF	AF	Colorado	US	DRU	NORTHCOM
USNS Alan T Shepard T-AKE-3		NAVY	FLOATING	US	NULL	NORTHCOM
USNS Amelia Earhart T-AKE-6		NAVY	FLOATING	US	NULL	NORTHCOM
USNS BIG HORN AO 198		NAVY	FLOATING	US	NULL	NORTHCOM
USNS CARL BRASHEAR T-AKE-7		NAVY	FLOATING	US	NULL	NORTHCOM
USNS Charles Drew		NAVY	FLOATING	US	NULL	NORTHCOM
USNS DIEHL AO 193		NAVY	FLOATING	US	NULL	NORTHCOM
USNS GRUMMAN A0 195		NAVY	FLOATING	US	NULL	NORTHCOM
USNS GUADALUPE AO 200		NAVY	FLOATING	US	NULL	NORTHCOM
USNS HARRY MARTIN		DESC	FLOATING	US	NULL	NORTHCOM
USNS HENRY KAISER		NAVY	FLOATING	US	NULL	NORTHCOM
USNS JOHN ERICSSON AO 194		NAVY	FLOATING	US	NULL	NORTHCOM
USNS JOHN LENTHALL TAO 189		NAVY	FLOATING	US	NULL	NORTHCOM
USNS Joshua Humphreys TAO-188		NAVY	FLOATING	US	NULL	NORTHCOM
USNS KANAWHA AO 196		NAVY	FLOATING	US	NULL	NORTHCOM
USNS LARAMIE AO 203		NAVY	FLOATING	US	NULL	NORTHCOM
USNS LEWIS AND CLARK T-AKE-1		NAVY	FLOATING	US	NULL	NORTHCOM
USNS MATTHEW PERRY TAKE 9		NAVY	FLOATING	US	NULL	NORTHCOM
USNS PATUXENT AO 201		NAVY	FLOATING	US	NULL	NORTHCOM
USNS PEARY T-AKE-5		NAVY	FLOATING	US	NULL	NORTHCOM
USNS PECOS AO 197		NAVY	FLOATING	US	NULL	NORTHCOM
USNS RAPPAHANNOCK A0 204		NAVY	FLOATING	US	NULL	NORTHCOM
USNS Richard E Byrd T-AKE-4		NAVY	FLOATING	US	NULL	NORTHCOM
USNS SACAGAWEA T-AKE-2		NAVY	FLOATING	US	NULL	NORTHCOM
USNS STOCKHAM		DESC	FLOATING	US	NULL	NORTHCOM
USNS SUPPLY AOE 6		NAVY	FLOATING	US	NULL	NORTHCOM
USNS TIPPECANOE AO 199		NAVY	FLOATING	US	NULL	NORTHCOM
USNS Wally SCHIRRA T-AKE-8		NAVY	FLOATING	US	NULL	NORTHCOM
USNS WHEAT		DESC	FLOATING	US	NULL	NORTHCOM
USNS YUKON AO 202		NAVY	FLOATING	US	NULL	NORTHCOM
USS ABRAHAM LINCOLN CV 72		NAVY	FLOATING	US	NULL	NORTHCOM
USS ARCTIC AOE 98		NAVY	FLOATING	US	NULL	NORTHCOM
USS BATAAN LHD 5		NAVY	FLOATING	US	NULL	NORTHCOM
USS BONHOMME RICHARD LHD 6		NAVY	FLOATING	US	NULL	NORTHCOM
USS BOXER LHD 4		NAVY	FLOATING	US	NULL	NORTHCOM
USS BRIDGE AOE 1O		NAVY	FLOATING	US	NULL	NORTHCOM
USS CARL VINSON CVN 70		NAVY	FLOATING	US	NULL	NORTHCOM
USS EISENHOWER CVN 69		NAVY	FLOATING	US	NULL	NORTHCOM
USS ENTERPRISE CVN 65		NAVY	FLOATING	US	NULL	NORTHCOM
USS ESSEX LHD 2		NAVY	FLOATING	US	NULL	NORTHCOM

USS GEORGE H W BUSH CVN 77		NAVY	Virginia	US	NULL	NORTHCOM
USS GEORGE WASHINGTON		NAVY	FLOATING	US	NULL	NORTHCOM
USS HARRY TRUMAN CVN 75		NAVY	FLOATING	US	NULL	NORTHCOM
USS IWO JIMA LHD 7		NAVY	FLOATING	US	NULL	NORTHCOM
USS JOHN STENNIS CVN 74		NAVY	FLOATING	US	NULL	NORTHCOM
USS KEARSAGE LHD 3		NAVY	FLOATING	US	NULL	NORTHCOM
USS MAKIN ISLAND LHD 8		NAVY	FLOATING	US	NULL	NORTHCOM
USS NASSAU LHA 4		NAVY	FLOATING	US	NULL	NORTHCOM
USS NIMITZ CVN 68		NAVY	FLOATING	US	NULL	NORTHCOM
USS PELELIU LHA 5		NAVY	FLOATING	US	NULL	NORTHCOM
USS RAINER AOE 7		NAVY	FLOATING	US	NULL	NORTHCOM
USS RONALD REAGAN CVN 76		NAVY	FLOATING	US	NULL	NORTHCOM
USS ROOSEVELT CVN 71		NAVY	FLOATING	US	NULL	NORTHCOM
USS WASP LHD 1		NAVY	FLOATING	US	NULL	NORTHCOM
UTES2 Greenville		ARMY	Kentucky	US	NGB	NORTHCOM
Vance AFB	KEND	AF	Oklahoma	US	AETC	NORTHCOM
Vancouver		DESC	Washington	US	NULL	NORTHCOM
Vandenberg AFB	KVBG	AF	California	US	AFSPC	NORTHCOM
Volk Field		AF	Wisconsin	US	ANG	NORTHCOM
Waterloo AASF#2		ARMY	Iowa	US	NGB	NORTHCOM
West Point		ARMY	New York	US	IMCOM	NORTHCOM
Westhampton Beach	KFOK	AF	New York	US	ANG	NORTHCOM
Westover ARB	KCEF	AF	Massachusetts	US	AFRC	NORTHCOM
WHEELING		ARMY	West Virginia	US	NGB	NORTHCOM
White Sands Missile Range		ARMY	New Mexico	US	IMCOM	NORTHCOM
Whiteman AFB	KSZL	AF	Missouri	US	AFGSC	NORTHCOM
Will Rogers Field ANG	KOKC	AF	Oklahoma	US	ANG	NORTHCOM
Willow Grove ANG	KNXX	AF	Pennsylvania	US	ANG	NORTHCOM
Wright Patterson	KFFO	AF	Ohio	US	AFMC	NORTHCOM
WV ARNG		ARMY	West Virginia	US	NGB	NORTHCOM
Yakima Training Center		ARMY	Washington	US	IMCOM	NORTHCOM
Youngstown		AF	Ohio	US	AFRC	NORTHCOM
Yuma Proving Ground	KYUM	ARMY	Arizona	US	IMCOM	NORTHCOM
AASF Bethel		ARMY	Alaska	US	NGB	PACOM
Andersen AFB	PGUA	AF	OCONUS	Guam	PACAF	PACOM
Barking Sands	PHBK	NAVY	Hawaii	US	NULL	PACOM
Bryant AAF		ARMY	Alaska	US	NGB	PACOM
Camp Carroll, Area 4		ARMY	OCONUS	South Korea	IMCOM	PACOM
Camp Humphreys Area 3A		ARMY	OCONUS	South Korea	IMCOM	PACOM
Camp Humphreys, Area 3		ARMY	OCONUS	South Korea	IMCOM	PACOM

Camp Red Cloud Area 1		ARMY	OCONUS	South Korea	IMCOM	PACOM
Camp Stanley Area 1		ARMY	OCONUS	South Korea	IMCOM	PACOM
Camp Walker Area 4		ARMY	OCONUS	South Korea	IMCOM	PACOM
CHINHAE		NAVY	OCONUS	South Korea	NULL	PACOM
CP CASEY, AREA I GAS		ARMY	OCONUS	South Korea	IMCOM	PACOM
Daegu AB		AF	OCONUS	South Korea	PACAF	PACOM
DFSP Akasaki		NAVY	OCONUS	Japan	NULL	PACOM
DFSP Anchorage		DESC	Alaska	US	NULL	PACOM
DFSP GUNSAN2		DESC	OCONUS	South Korea	NULL	PACOM
DFSP Hachinohe Terminal		NAVY	OCONUS	Japan	NULL	PACOM
DFSP HACINOHE II		DESC	OCONUS	Japan	NULL	PACOM
DFSP Hakozaki		NAVY	OCONUS	Japan	NULL	PACOM
DFSP Iorizaki		NAVY	OCONUS	Japan	NULL	PACOM
DFSP MCP Gas ST Okinawa		DESC	OCONUS	Japan	NULL	PACOM
DFSP PDSO Okinawa		ARMY	OCONUS	Okinawa	IMCOM	PACOM
DFSP Pearl Harbor		NAVY	Hawaii	US	NULL	PACOM
DFSP Pohang BD		DESC	OCONUS	South Korea	NULL	PACOM
DFSP Pyongtaek		DESC	OCONUS	South Korea	NULL	PACOM
DFSP Schofield		ARMY	Hawaii	US	IMCOM	PACOM
DFSP SENOKO		DESC	OCONUS	Singapore	NULL	PACOM
DFSP SONGNAM		DESC	OCONUS	South Korea	NULL	PACOM
DFSP Tsurumi		NAVY	OCONUS	Japan	NULL	PACOM
DFSP UIJONGBU		DESC	OCONUS	South Korea	NULL	PACOM
DFSP ULSAN		DESC	OCONUS	South Korea	NULL	PACOM
DFSP WAEGWAN		DESC	OCONUS	South Korea	NULL	PACOM
DFSP Yechon		DESC	OCONUS	South Korea	NULL	PACOM
DFSP Yokose		NAVY	OCONUS	Japan	NULL	PACOM
Eareckson AFB		AF	Alaska	US	PACAF	PACOM
Eielson AFB	PAEI	AF	Alaska	US	PACAF	PACOM
Elmendorf AFB	PAED	AF	Alaska	US	PACAF	PACOM
Fort Greely		ARMY	Alaska	US	IMCOM	PACOM
Fort Wainwright		ARMY	Alaska	US	IMCOM	PACOM
Gimhae AB		AF	OCONUS	South Korea	PACAF	PACOM
Guam 2		NAVY	OCONUS	Guam	NULL	PACOM
H&HS Log Dept. Iwakuni		NAVY	OCONUS	Japan	NULL	PACOM
Hickam AFB	PHNO PHIK	AF	Hawaii	US	PACAF	PACOM
Hickam ANG	PHNO PHIK	AF	Hawaii	US	ANG	PACOM
Juneau		ARMY	Alaska	US	NGB	PACOM
K-16 Seoul AB		ARMY	OCONUS	South Korea	IMCOM	PACOM
Kadena AB	RODN	AF	OCONUS	Okinawa	PACAF	PACOM

King Salmon Airport	PAKN	AF	Alaska	US	PACAF	PACOM
Kulis ANGB		AF	Alaska	US	ANG	PACOM
KUNSAN AB KOREA	RKJK	AF	OCONUS	South Korea	PACAF	PACOM
Kwajalein Missile Range		ARMY	OCONUS	Kwajalein	SMDC	PACOM
KWANG JU AB KOREA		AF	OCONUS	South Korea	PACAF	PACOM
MCAS Futenma		NAVY	OCONUS	Japan	NULL	PACOM
MCAS Kaneohe Bay	PHNG	NAVY	Hawaii	US	NULL	PACOM
Misawa AB	RJSM	AF	OCONUS	Japan	PACAF	PACOM
NAF Atsugi		NAVY	OCONUS	Japan	NULL	PACOM
Nome		ARMY	Alaska	US	NGB	PACOM
NSF DIEGO GARCIA	FJDG	NAVY	OCONUS	United Kingdom	NULL	PACOM
Osan AB	RKSO	AF	OCONUS	South Korea	PACAF	PACOM
Pohakuloa Training Area		ARMY	Hawaii	US	IMCOM	PACOM
PWC GUAM		NAVY	OCONUS	Guam	NULL	PACOM
PWC Pearl Harbor		NAVY	Hawaii	US	NULL	PACOM
Subic Bay		DESC	OCONUS	Philippines	NULL	PACOM
Suwon AB		AF	OCONUS	South Korea	PACAF	PACOM
Tungduchon		ARMY	OCONUS	South Korea	IMCOM	PACOM
US Naval Sta-Mariana Isl		NAVY	OCONUS	Guam	NULL	PACOM
Wake Island	PWAK	AF	OCONUS	Wake Island	PACAF	PACOM
Wheeler Army Airfield		ARMY	Hawaii	US	IMCOM	PACOM
Yokota AB	RJTY	AF	OCONUS	Japan	PACAF	PACOM
Yongsan Area 2		ARMY	OCONUS	South Korea	IMCOM	PACOM

APPENDIX B: Into Plane Contract Locations

Location	ICAO	State	Award Price
ABBEVILLE CHRIS CRUSTA MEMORIAL AIRPORT	K0R3	LA	2.8048
ABILENE RGNL	KABI	TX	2.9955
ABRAHAM LINCOLN CAPITAL (SPRINGFIELD)	KSPI	IL	3.7614
ABUJA NNAMDI AZIKIWE INTL	DNAA	OS	3.00075
ABUJA NNAMDI AZIKIWE INTL	DNAA	OS	3.00075
ACADIANA RGNL	KARA	LA	2.9346
ACADIANA RGNL	KARA	LA	2.8596
ACCRA KOTOKA INTL	DGAA	OS	3.195406
ACCRA KOTOKA INTL	DGAA	OS	3.195406
ADAK ISLAND	PADK	AK	0
ADAMS FLD	KLIT	AR	2.7928
ADDISON AIRPORT DALLAS	KADS	TX	4.225505
AGUADILLA/BORINQUEN	TJBQ	OS	0
AGUADILLA/BORINQUEN	TJBQ	OS	0
AKRON CANTON RGNL	KCAK	OH	2.602
AKRON CANTON RGNL	KCAK	OH	2.602
ALAJUELA(SAN JOSE)/JUAN SANTAMARIA INTL	MROC	OS	4.6144
ALBERT J ELLIS (JACKSONVILLE)	KOAJ	NC	4.49
ALBUQUERQUE INTL SUNPORT (KIRTLAND AFB)	KABQ	NM	2.62429
ALEXANDRIA INTL	KAEX	LA	3.2463
ALFONSO BONILLA ARAGON APT. CALI	SKCL	OS	2.7433
ALGER/HOUARI BOUMEDIENE	DAAG	OS	0
ALICE SPRINGS	YBAS	OS	3.25
ALLEN C PERKINSON BLACKSTONE AAF (FORT PICKETT)	KBKT	VA	4.008275
ALMATY	UAAA	OS	0
AMILCAR CABRAL INTL/ SAL I.	GVAC	OS	0
AMILCAR CABRAL INTL/ SAL I.	GVAC	OS	2.43264
ANKENY RGNL	KIKV	IA	3.93289
ANNISTON METRO	KANB	AL	2.82839
ANTOFAGASTA/INTL CERRO MORENO (EXERCISES ONLY)	SCFA	OS	3.5955
AQABA KING HUSSEIN INTL	OJAQ	OS	0
ARBA MINCH	HAAM	OS	0
ARLANDA	ESSA	OS	2.2523
ARNOLD PALMER RGNL (LATROBE)	KLBE	PA	3.98761
ASHEVILLE RGNL	KAVL	NC	4.3283
ASHGABAT	UTAA	OS	2.42683

ASHGABAT	UTAA	OS	2.50544
ASTANA INTL	UACC	OS	0
ASTORIA RGNL	KAST	OR	3.1767
ATATURK	LTBA	OS	2.202
ATHENS BEN EPPS	KAHN	GA	3.87843
AUGUSTA RGNL AT BUSH FLD	KAGS	GA	4.305935
AURORA MUNI	KARR	IL	3.8196
AUSTIN BERGSTROM INTL	KAUS	TX	2.4964
AUSTIN STRAUBEL INTL	KGRB	WI	3.06879
BAGHDAD INTL	ORBI	OS	3.72927
BAHRAIN INTL	OBBI	OS	2.3575
BAHRAIN INTL	OBBI	OS	2.3675
BAKU/	UBBB	OS	0
BALICE	EPKK	OS	0
BANGOR INTL	KBGR	ME	3.797619
BANGOR INTL	KBGR	ME	3.847619
BARKLEY RGNL (PADUCAH)	KPAH	KY	3.73369
BARRANQUILLA/ERNESTO CORTISSOZ	SKBQ	OS	2.6407
BARSTOW DAGGETT	KDAG	CA	3.86
BARSTOW DAGGETT	KDAG	CA	3.82
BATON ROUGE METRO RYAN FLD	KBTR	LA	0
Bay Minette	K1R8	AL	3.74219
BEAUMONT MUNI	KBMT	TX	3.189
BELIZE CITY/PHILIP S.W. GOLDSON INTL	MZBZ	OS	0
BELLINGHAM INTL	KBLI	WA	2.5086
BELLINGHAM INTL	KBLI	WA	2.4586
BEN GURION	LLBG	OS	2.2262
BENAZIR BHUTTO INTL	OPRN	OS	0
BIG SANDY RGNL (PRESTONSBURG)	KK22	KY	0
BIGGS AAF (FORT BLISS)	KBIF	TX	2.5191
BILLINGS LOGAN INTL	KBIL	MT	2.5413
BIRMINGHAM INTL	KBHM	AL	0
BIRMINGHAM INTL	KBHM	AL	2.9691
BIRMINGHAM INTL	KBHM	AL	2.9191
BISMARCK MUNI	KBIS	ND	2.29809
BLUE GRASS (LEXINGTON)	KLEX	KY	3.32453
BLYTHE	KBLH	CA	0
BLYTHE	KBLH	CA	0
BOB HOPE (BURBANK)	KBUR	CA	0
BOEING FLD KING CO INTL	KBFI	WA	2.3997

BOEING FLD KING CO INTL	KBFI	WA	2.222605
BOGOTA/ELDORADO	SKBO	OS	2.7063
BOISE AIR TERMINAL (GOWEN FLD)	KBOI	ID	2.325005
BOISE AIR TERMINAL (GOWEN FLD)	KBOI	ID	2.375005
BOLE INTL	HAAB	OS	3.534218
BOLE INTL	HAAB	OS	3.534218
BRADLEY INTL	KBDL	CT	4.4724
BRADLEY INTL	KBDL	CT	4.4224
BREMERTON NATIONAL	KPWT	WA	3.3835
BRIDGETOWN/GRANTLY ADAMS INTL	TBPB	OS	0
BRISBANE INTL	YBBN	OS	2.4285
BRNO/TURANY	LKTB	OS	0
Brooks County Airport	KBKS	TX	3.87259
BROWN FLD MUNI (SAN DIEGO)	KSDM	CA	3.031596
BROWNSVILLE SOUTH PADRE ISLAND INTL	KBRO	TX	2.6482
BROWNWOOD RGNL	KBWD	TX	3.07259
BRUNSWICK GOLDEN ISLES	KBQK	GA	4.244005
BRUSSELS/NATIONAL	EBBR	OS	2.14876
BUENOS AIRES ELEIZA IAP	SAEZ	OS	2.69616
BUFFALO NIAGARA INTL	KBUF	NY	4.1349
BUFFALO NIAGARA INTL	KBUF	NY	4.1824
BURGAS APT BULGARIA	LBBG	OS	2.6578
BURGAS APT BULGARIA	LBBG	OS	2.80282
BURKE LAKEFRONT (CLEVELAND)	KBKL	OH	3.90629
BUTTE/BERT MOONEY MT.	KBTM	MT	3.3409
Cairo IAP Egypt	HECA	OS	0
Cairo IAP Egypt	HECA	OS	2.23
CANBERRA (FAIRBAIRN)	YSCB	OS	2.7956
CAPE GIRARDEAU MUNI	KCGI	MO	3.4077
CAPE TOWN INTL	FACT	OS	0
CAPE TOWN INTL	FACT	OS	2.1891
CAPITAL CITY	KFFT	KY	2.7874
CAPITAL CITY (HARRISBURG)	KCXY	PA	0
CAPODICHINO	LIRN	OS	2.6304
CARPIOUET	LFRK	OS	2.974
CARTAGENA/RAFAEL NUNEZ APT	SKCG	OS	2.6286
CARTHAGE	DTTA	OS	0
CARTHAGE	DTTA	OS	2.72656
CASALE	LIBR	OS	2.9554
CASTLE (MERCED)	KMER	CA	3.0933

CECIL FLD (JACKSONVILLE)	KVQQ	FL	4.27924
CECIL FLD (JACKSONVILLE)	KVQQ	FL	4.06924
CEDAR CITY UT	KCDC	UT	0
CENTENNIAL (DENVER)	KAPA	CO	3.3578
CENTRAL NEBRASKA RGNL	KGRI	NE	3.92319
CHARLEROI/GOSSELIES BRUSSELS SOUTH	EBCI	OS	2.42876
CHARLEROI/GOSSELIES BRUSSELS SOUTH	EBCI	OS	2.42876
CHARLESTON AFB INTL	KCHS	SC	3.849343
CHARLESTON AFB INTL	KCHS	SC	3.799343
CHARLOTTE CO (PUNTA GORDA)	KPGD	FL	4.152944
CHARLOTTE DOUGLAS INTL	KCLT	NC	3.9801
CHARLOTTESVILLE ALBEMARLE	KCHO	VA	4.4105
CHARLOTTESVILLE ALBEMARLE	KCHO	VA	4.3605
CHENNAULT INTL	KCWF	LA	2.2008
CHENNAULT INTL	KCWF	LA	3.2054
CHEROKEE CO	KJSO	TX	0
CHERRY CAPITAL	KTVC	MI	3.73062
CHERRY CAPITAL	KTVC	MI	3.83062
CHEYENNE RGNL JERRY OLSON FLD	KCYS	WY	3.9192
CHIANG MAI IAP	VTCC	OS	2.545
CHICAGO MIDWAY INTL	KMDW	IL	3.7014
CHICAGO OHARE INTL	KORD	IL	4.55953
CHICAGO/ROCKFORD INTL	KRFD	IL	3.7659
CHICO	KCIC	CA	0
CHRISTCHURCH INTL	NZCH	OS	2.8032
CHRISTCHURCH INTL	NZCH	OS	2.7532
CIAMPINO	LIRA	OS	2.3604
CINCINNATI MUNI LUNKEN FLD	KLUK	OH	3.6889
CITY OF COLORADO SPRINGS MUNI (PETERSON FLD)	KCOS	CO	3.1255
CITY OF COLORADO SPRINGS MUNI (PETERSON FLD)	KCOS	CO	3.1755
CLARK INTL	RPLC	OS	2.869988
CLARK INTL	RPLC	OS	2.869988
CLEVELAND HOPKINS INTL	KCLE	OH	3.9354
CLINTON SHERMAN	KCSM	OK	2.9182
COLD BAY	PACD	AK	0
COLUMBIA METROPOLITAN	KCAE	SC	3.711
COLUMBIA OWENS DOWNTOWN	KCUB	SC	4.12195
COLUMBIA RGNL	KCOU	MO	3.42864
COLUMBUS MUNI	KBAK	IN	3.75558
CONAKRY	GUCY	OS	3.3204

CORPUS CHRISTI INTL	KCRP	TX	2.38339
COTABATO APT/MINDANAO ISL	RPMC	OS	2.994988
CURTIS FLD	KBBD	TX	2.8436
CURTIS FLD	KBBD	TX	2.8436
CURTIS FLD	KBBD	TX	2.8336
DALLAS LOVE FLD	KDAL	TX	2.48649
DALLAS LOVE FLD	KDAL	TX	2.49649
DANE CO RGNL TRUAX FLD (TRUAX FLD)	KMSN	WI	3.82589
DAVID WAYNE HOOKS MEM	KDWH	TX	3.1375
DAVIS FLD	KMKO	OK	3.066
DAYTONA BEACH INTL	KDAB	FL	4.023678
DAYTONA BEACH INTL	KDAB	FL	4.043678
DEKALB PEACHTREE (ATLANTA)	KPDK	GA	4.179214
DEKALB PEACHTREE (ATLANTA)	KPDK	GA	4.229214
DEL RIO IAP DEL RIO	KDRT	TX	3.47089
DELHI/INDIRA GANDHI INTL	VIDP	OS	2.2989
DENVER INTL	KDEN	CO	3.66949
DES MOINES INTL	KDSM	IA	0
DES MOINES INTL	KDSM	IA	0
DETROIT METRO WAYNE CO	KDTW	MI	4.0076
DETROIT/WILLOW RUN	KYIP	MI	3.56294
DHAKA/ZIA INTL	VGZR	OS	0
DINWIDDIE CO (PETERSBURG)	KPTB	VA	4.112
DIORIHAMANI	DRRN	OS	3.696366
DIORIHAMANI	DRRN	OS	3.696366
DJIBOUTI/AMBOULI	HDAM	OS	2.38954
DJIBOUTI/AMBOULI	HDAM	OS	2.38954
DOHA INTL	OTBD	OS	2.67
DON MUEANG INTL	VTBD	OS	2.2639
DONALDSON CENTER (GREENVILLE)	KGYH	SC	3.7987
DOTHAN RGNL	KDHN	AL	2.7378
DOTHAN RGNL	KDHN	AL	2.7678
DOUALA	FKKD	OS	2.570543
DOUALA	FKKD	OS	2.570543
DOUBLE EAGLE II	KAEG	NM	3.4627
DRAUGHON MILLER CENTRAL TEXAS RGNL	KTPL	TX	2.44
DRESDEN	EDDC	OS	2.58085
Dubai IAP U.A.E.	OMDB	OS	2.2896
DUBLIN	EIDW	OS	2.524
DULUTH INTL	KDLH	MN	3.40468

DUSHANBE	UTDD	OS	3.2561
EAGLE CO RGNL	KEGE	CO	2.8879
EAST TEXAS RGNL	KGGG	TX	2.74399
EASTERN SIERRA RGNL	KBIH	CA	3.1499
EASTERWOOD FLD	KCLL	TX	3.0454
EASTON NEWNAM FLD	KESN	MD	4.3398
EDINBURGH	EGPH	OS	2.234
EL PASO INTL	KELP	TX	2.4976
EL PASO INTL	KELP	TX	2.4826
ELEFTHERIOS VENIZELOS INTL	LGAV	OS	2.3195
ELLINGTON FLD	KEFD	TX	0
ELLINGTON FLD	KEFD	TX	2.78049
ELLINGTON FLD	KEFD	TX	2.49889
ELLINGTON FLD	KEFD	TX	2.52889
ELLINGTON FLD	KEFD	TX	2.23889
ENID WOODRING RGNL	KWDG	OK	3.4502
ENTEBBE INTL	HUEN	OS	2.46944
ENTEBBE INTL	HUEN	OS	2.46944
EPPLEY AFLD (OMAHA)	KOMA	NE	3.30861
ERFURT	EDDE	OS	2.76085
ERNEST A LOVE FLD	KPRC	AZ	2.9577
ERNEST A LOVE FLD	KPRC	AZ	3.0412
ESENBOGA	LTAC	OS	0
ESLER RGNL	KESF	LA	2.2508
ESLER RGNL	KESF	LA	3.23132
EVANSVILLE RGNL	KEVV	IN	3.79
EVENES	ENEV	OS	0
EXECUTIVE (ORLANDO)	KORL	FL	4.327148
EXECUTIVE (ORLANDO)	KORL	FL	4.267148
FAIRBANKS INTL	PAFA	AK	3.25961
FAYETTEVILLE RGNL GRANNIS FLD	KFAY	NC	4.109
FAYETTEVILLE/DRAKE FLELD ARK	KFYV	AR	0
FAYETTEVILLE/DRAKE FLELD ARK	KFYV	AR	3.3054
FERIHEGY APT	LHBP	OS	2.4046
FLAGSTAFF PULLIAM	KFLG	AZ	3.3803
FLORALA MUNI	K0J4	AL	3.1108
FLORALA MUNI	K0J4	AL	3.1508
FLORENCE RGNL	KFLO	SC	3.970805
FORBES FLD (TOPEKA)	KFOE	KS	3.903
FORT LAUDERDALE HOLLYWOOD INTL	KFLL	FL	3.643218

FORT LAUDERDALE HOLLYWOOD INTL	KFLL	FL	3.703218
FORT SMITH RGNL	KFSM	AR	3.04929
FORT WORTH ALLIANCE	KAFW	TX	3.0098
FORT WORTH MEACHAM INTL	KFTW	TX	2.40279
FOUR CORNERS RGNL	KFMN	NM	2.86219
FRANKFURT MAIN	EDDF	OS	0
FRANKFURT MAIN	EDDF	OS	2.6863
FREDERICK MUNI	KFDK	MD	4.429725
FREDERICK MUNI	KFDK	MD	4.479725
FRESNO YOSEMITE INTL	KFAT	CA	2.421371
FRESNO YOSEMITE INTL	KFAT	CA	2.191471
FUJAIRAH IAP UNITED ARAB EMIRATES	OMFJ	OS	2.332536
FUJAIRAH IAP UNITED ARAB EMIRATES	OMFJ	OS	2.582536
FUKUOKA APT	RJFF	OS	0
FULTON CO ARPT BROWN FLD (ATLANTA)	KFTY	GA	3.985305
GABORONE/SIR SERETSE KHAMA	FBSK	OS	3.8541
GABORONE/SIR SERETSE KHAMA	FBSK	OS	3.8541
GAINESVILLE RGNL	KGNV	FL	3.5999
GALLATIN FLD	KBZN	MT	2.7988
GARDEN CITY RGNL	KGCK	KS	3.55822
GARY CHICAGO INTL	KGYY	IN	3.23
GENERAL WM J FOX AFLD (LANCASTER)	KWJF	CA	0
GENERAL WM J FOX AFLD (LANCASTER)	KWJF	CA	0
GEORGE BUSH INTCNTL HOUSTON	KIAH	TX	2.9204
GLACIER PARK INTL (KALISPELL)	KFCA	MT	3.1213
GLASGOW	EGPF	OS	2.234
GOLDEN TRIANGLE RGNL	KGTR	MS	2.8945
GRAND CANYON NATL PARK	KGCN	AZ	3.4186
GRAND CAYMAM/OWEN ROBERTS INTL	MWCR	OS	0
GRAND FORKS INTL	KGFK	ND	0
GRAND JUNCTION RGNL	KGJT	CO	4.1703
GRAND JUNCTION RGNL	KGJT	CO	4.2303
GRAND STRAND	KCRE	SC	4.682905
GRANT CO INTL	KMWH	WA	0
GRANT CO INTL	KMWH	WA	3.156005
GREAT FALLS INTL	KGTF	MT	2.9078
GREAT FALLS INTL	KGTF	MT	3.0215
GREENVILLE SPARTANBURG INTL ROGER MILLIKEN	KGSP	SC	4.352
GREENVILLE SPARTANBURG INTL ROGER MILLIKEN	KGSP	SC	4.302
GREENWOOD LEFLORE	KGWO	MS	0

GRENADA MUNI	KGNF	MS	0
GROTON NEW LONDON	KGON	CT	3.927804
GUATEMALA CITY/LA AURORA	MGGT	OS	2.5092
GULFPORT BILOXI INTL	KGPT	MS	3.076615
GULFPORT BILOXI INTL	KGPT	MS	3.016615
GUVERCINUK (MIL)	LTAB	OS	0
HAGERSTOWN RGNL RICHARD A HENSON FLD	KHGR	MD	4.3846
HAGERSTOWN RGNL RICHARD A HENSON FLD	KHGR	MD	4.4346
HAMBURG	EDDH	OS	2.299
HAMMOND NORTHSHORE RGNL	KHDC	LA	2.4126
HARDY ANDERS FLD NATCHEZ ADAMS CO	KHEZ	MS	2.8639
HARRISBURG INTL	KMDT	PA	4.437375
HARRISBURG INTL	KMDT	PA	4.487375
HATTIESBURG BOBBY L CHAIN MUNI	KHBG	MS	2.9781
HATTIESBURG BOBBY L CHAIN MUNI	KHBG	MS	2.8881
HATTIESBURG LAUREL RGNL	KPIB	MS	2.8933
HAWKINS FLD	KHKS	MS	2.81675
HECTOR INTL (FARGO)	KFAR	ND	3.7453
HELENA RGNL	KHLN	MT	3.5008
HENRI COANDA	LROP	OS	2.581
HENRI COANDA	LROP	OS	2.466
HENRI COANDA	LROP	OS	2.466
HENRI COANDA	LROP	OS	2.531
HERNANDO CO	KBKV	FL	4.038419
HILO INTL (GENERAL LYMAN FLD)	PHTO	HI	2.7139
HONK KONG/CHEP LAP KOK INTL	VHHH	OS	2.12486
HONOLULU INTL (HICKAM AFB)	PHNL	HI	2.49852
HUNTSVILLE INTL CARL T JONES FLD	KHSV	AL	3.02059
HUNTSVILLE INTL CARL T JONES FLD	KHSV	AL	3.10059
HUNTSVILLE MUNI	KUTS	TX	3.3228
HUTCHINSON MUNI	KHUT	KS	3.779
IDAHO FALLS RGNL	KIDA	ID	3.189094
IMPERIAL CO	KIPL	CA	3.177096
IMPERIAL CO	KIPL	CA	2.977096
INDIANAPOLIS INTL	KIND	IN	3.19568
INDIANAPOLIS INTL	KIND	IN	3.19568
IOANNIS KAPODISTRIAS INTL	LGKR	OS	2.6495
IQUIQUE/DIEGO ARACENA IAP (EXERCISES ONLY)	SCDA	OS	3.5955
JACK EDWARDS APT GULF SHORES	KJKA	AL	4.29829
JACKSON EVERS INTL	KJAN	MS	3.0354

JACKSONVILLE INTL	KJAX	FL	3.698219
JACKSONVILLE INTL	KJAX	FL	3.768219
JAKARTA/HALIM PERDANAKUSUMA	WIIH	OS	3.2565
JAMES M COX DAYTON INTL	KDAY	OH	2.81
JAMES M COX DAYTON INTL	KDAY	OH	2.81
JEFFERSON CITY MEM	KJEF	MO	3.3667
JOE FOSS FLD (SIOUX FALLS)	KFSD	SD	4.28489
JOHN F KENNEDY INTL	KJFK	NY	4.08004
JOHN MURTHA JOHNSTOWN CAMBRIA CO	KJST	PA	4.8459
JOHN MURTHA JOHNSTOWN CAMBRIA CO	KJST	PA	4.8959
JOPLIN REGIONAL	KJLN	MO	3.4759
JOSE JOAQUIN DE OLMEDO INTL	SEGU	OS	0
JOSLIN FLD MAGIC VALLEY RGNL	KTWF	ID	2.9761
JOSLIN FLD MAGIC VALLEY RGNL	KTWF	ID	3.0261
JULIUS NYERERE	HTDA	OS	2.42
JULIUS NYERERE	HTDA	OS	2.42
JUNEAU INTL	PAJN	AK	2.9318
JUNEAU INTL	PAJN	AK	2.9818
KAHULUI	PHOG	HI	2.68629
KANGERLUSSUAQ	BGSF	OS	0
KANSAS CITY INTL	KMCI	MO	0
KANSAS CITY INTL	KMCI	MO	0
KASTRUP	EKCH	OS	2.17585
KEFLAVK INTL	BIKF	OS	0
KEFLAVK INTL	BIKF	OS	0
Ketchikan IAP Ketchikan	PAKT	AK	0
Ketchikan IAP Ketchikan	PAKT	AK	0
KEY FLD	KMEI	MS	2.99309
KHORAT (EXERCISES ONLY)	VTUN	OS	2.995
KIEV/BORISPIL	UKBB	OS	3.0881
KILIMANJARO IAP	HTKJ	OS	2.99
KILIMANJARO IAP	HTKJ	OS	2.99
KING ABDULAZIZ AB	OEDR	OS	2.4526
KING ABDULAZIZ AB	OEDR	OS	2.4716
KING KHALED AB	OEKM	OS	2.6508
KING KHALID INTL	OERK	OS	2.4526
KINGSTON/NORMAN MANLEY INT	MKJP	OS	2.37012
KINSHASA/N'DJILI	FZAA	OS	3.040496
KINSHASA/N'DJILI	FZAA	OS	3.040496
KIRUNA	ESNQ	OS	0

KLAMATH FALLS (KINGSLEY FLD)	KLMT	OR	3.145175
KLAMATH FALLS (KINGSLEY FLD)	KLMT	OR	3.095175
KOLN-BONN	EDDK	OS	2.25563
KONA INTL AT KEAHOLE	PHKO	HI	2.79412
KONA INTL AT KEAHOLE	PHKO	HI	2.76412
KOTZEBUE	PAOT	AK	0
KUWAIT/INTL	OKBK	OS	2.3395
KUWAIT/INTL	OKBK	OS	0
LA CEIBA/GOLOSON INTL	MHLC	OS	2.565
LA CROSSE MUNI	KLSE	WI	3.80219
LA PAZ/KENNEDY INTL	SLLP	OS	0
LACKLAND AFB KELLY FLD ANNEX	KSKF	TX	0
LACKLAND AFB KELLY FLD ANNEX	KSKF	TX	3.3443
LACKLAND AFB KELLY FLD ANNEX	KSKF	TX	0.33
LACKLAND AFB KELLY FLD ANNEX	KSKF	TX	0.33
LAFAYETTE RGNL	KLFT	LA	2.2678
LAKE CHARLES RGNL	KLCH	LA	3.4351
LAKEFRONT	KNEW	LA	2.2758
LAKELAND LINDER RGNL	KLAL	FL	4.41962
LAMBERT ST LOUIS INTL	KSTL	MO	3.09279
LAMBERT ST LOUIS INTL	KSTL	MO	3.15279
LANSERIA	FALA	OS	0
LANSERIA	FALA	OS	0
LAREDO INTL	KLRD	TX	2.44539
LAREDO INTL	KLRD	TX	2.47539
LARNACA	LCLK	OS	2.3895
LAS CRUCES INTL	KLRU	NM	2.87709
LAUGHLIN BULLHEAD INTL (BULLHEAD CITY)	KIFP	AZ	3.4368
LAURENCE G HANSCOM FLD (BEDFORD)	KBED	MA	4.354682
LAURENCE G HANSCOM FLD (BEDFORD)	KBED	MA	4.254682
LAURINBURG MAXTON	KMEB	NC	4.3144
LAWTON FORT SILL RGNL	KLAW	OK	3.4185
LAWTON FORT SILL RGNL	KLAW	OK	3.4585
LE BOURGET	LFPB	OS	2.40075
LENNART MERI TALLINN	EETN	OS	2.3868
LEOPOLD SEDAR SENGHOR INTL	GOOY	OS	2.398908
LEOPOLD SEDAR SENGHOR INTL	GOOY	OS	2.398908
LEWISTOWN MUNI	KLWT	MT	3.3319
LF WADE INTL/BERMUDA	TXKF	OS	0
LIBERAL MID AMERICA RGNL	KLBL	KS	2.804

LIBERIA/D O QUIROS INTL	MRLB	OS	4.5494
LIBREVILLE LEON M'BA	FOOL	OS	3.310874
LIBREVILLE LEON M'BA	FOOL	OS	3.310874
LIHUE KAUAI I.	PHLI	HI	2.85216
LIMA-CALLAO/JORGE CHAVEZ INTL	SPIM	OS	0
LINCOLN	KLNK	NE	3.124
LINCOLN	KLNK	NE	3.074
LISBOA	LPPT	OS	2.189
LONDON CORBIN ARPT MAGEE FLD	KLOZ	KY	2.602
LONE STAR EXECUTIVE	KCXO	TX	2.7441
LONG BEACH (DAUGHERTY FLD)	KLGB	CA	2.3133
LONG BEACH (DAUGHERTY FLD)	KLGB	CA	2.2533
LONG ISLAND MAC ARTHUR	KISP	NY	3.99
LOS ANGELES INTL	KLAX	CA	2.392018
LOS ANGELES INTL	KLAX	CA	2.412018
LOUIS ARMSTRONG NEW ORLEANS INTL	KMSY	LA	2.4576
LOUIS ARMSTRONG NEW ORLEANS INTL	KMSY	LA	2.4176
LOUISVILLE INTL STANDIFORD FLD	KSDF	KY	3.70069
LOUISVILLE INTL STANDIFORD FLD	KSDF	KY	3.60069
LOVELL FLD	KCHA	TN	3.0924
LUBBOCK PRESTON SMITH INTL	KLBB	TX	2.618
LUQA INTL	LMML	OS	0
LUSAKMNTL	FLLS	OS	0
LUXOR INT'L	HELX	OS	2.515
LYNCHBURG RGNL PRESTON GLENN FLD	KLYH	VA	4.230105
LYNDEN PINDLING INTL	MYNN	OS	0
LYNDEN PINDLING INTL	MYNN	OS	0
MACDILL AFB AUX FLD (AVON PARK)	KAGR	FL	4.571599
MACTAN CEBU INTL	RPVM	OS	2.484988
MAHLON SWEET FLD (EUGENE)	KEUG	OR	3.1174
MAHLON SWEET FLD (EUGENE)	KEUG	OR	3.1674
MALAGA	LEMG	OS	2.259
MALCOLM MCKINNON (BRUNSWICK)	KSSI	GA	3.4724
MALPENSA	LIMC	OS	2.2404
MAMMOTH YOSEMITE	KMMH	CA	2.673
MANAGUA/A C SANDINO INTL	MNMG	OS	2.6498
MANCHESTER	KMHT	NH	3.974
MANHATTAN RGNL	KMHK	KS	3.94845
MANTA	SEMT	OS	0
MARKA INTL	OJAM	OS	0

MAUPERTUS	LFRC	OS	3.03075
MC ALLEN MILLER INTL	KMFE	TX	2.9557
MC ALLEN MILLER INTL	KMFE	TX	3.0157
MC CALL MUNI	KMYL	ID	0
MC CALL MUNI	KMYL	ID	0
MC CARRAN INTL (LAS VEGAS)	KLAS	NV	2.574115
MC CARRAN INTL (LAS VEGAS)	KLAS	NV	2.644115
MC CLELLAN AFLD (SACRAMENTO)	KMCC	CA	3.06624
MC COMB PIKE CO JOHN E LEWIS FLD	KMCB	MS	2.969
MC GHEE TYSON	KTYS	TN	2.7014
MC GHEE TYSON	KTYS	TN	2.7014
MC GHEE TYSON	KTYS	TN	2.6614
MC KELLAR SIPES RGNL	KMKL	TN	3.0223
MEADOWS FLD (BAKERSFIELD)	KBFL	CA	2.524505
MELBOURNE INTL	YMML	OS	2.446
MEMPHIS INTL	KMEM	TN	2.3912
MEMPHIS INTL	KMEM	TN	2.4212
MENARA	GMMX	OS	2.372264
MENARA	GMMX	OS	2.372264
METROPOLITAN OAKLAND INTL	KOAK	CA	2.661596
MIAMI INTL	KMIA	FL	4.338078
MIAMI INTL	KMIA	FL	4.398078
MID DELTA RGNL (GREENVILLE)	KGLH	MS	3.0337
MID OHIO VALLEY RGNL	KPKB	WV	4.352305
MID OHIO VALLEY RGNL	KPKB	WV	4.372305
MIDDLE GEORGIA RGNL (MACON)	KMCN	GA	4.2307
MIDLAND INTL	KMAF	TX	2.7988
MIHAIL KOGALNICEANU	LRCK	OS	2.606
MIHAIL KOGALNICEANU	LRCK	OS	2.681
MIHAIL KOGALNICEANU	LRCK	OS	2.556
MIHAIL KOGALNICEANU	LRCK	OS	2.681
MILLINGTON RGNL JETPORT	KNQA	TN	3.18269
MINERAL WELLS	KMWL	TX	3.2295
MINNEAPOLIS ST PAUL INTL (WOLD CHAMBERLAIN FLD)	KMSP	MN	3.6372
MINOT INTL	KMOT	ND	3.975
MINOT INTL	KMOT	ND	3.915
MISSOULA INTL	KMSO	MT	2.4424
MISSOULA INTL	KMSO	MT	2.4424
MOBILE DOWNTOWN	KBFM	AL	2.85589
MOBILE DOWNTOWN	KBFM	AL	2.78589

MOBILE RGNL	KMOB	AL	2.85579
MOBILE RGNL	KMOB	AL	2.78579
MOJAVE	KMHV	CA	3.128226
MOMBASA/MOI INTL	HKMO	OS	2.20511
MOMBASA/MOI INTL	HKMO	OS	2.20511
MONROE CO	KMVC	AL	3.23799
MONROE RGNL	KMLU	LA	2.559
MONROVIAIROBERTS INTL	GLRB	OS	0
MONROVIAIROBERTS INTL	GLRB	OS	0
MONTEREY PENINSULA	KMRY	CA	0
MONTEREY PENINSULA	KMRY	CA	0
MONTEVIDEO/CARRASCO INTL	SUMU	OS	3.323
MONTGOMERY RGNL	KMGM	AL	2.8488
MONTGOMERY RGNL	KMGM	AL	2.8788
MORGANTOWN MUNI WALTER L BILL HART FLD	KMGW	WV	4.342205
MORGANTOWN MUNI WALTER L BILL HART FLD	KMGW	WV	4.292205
MUNCHEN IAP	EDDM	OS	2.25863
MUSCAT INTL	OOMS	OS	2.257
MUSKEGON CO	KMKG	MI	3.5803
MYRTLE BEACH INTL	KMYR	SC	4.4748
NAIROBI JOMO KENYATTA INTL	HKJK	OS	2.20511
NAIROBI JOMO KENYATTA INTL	HKJK	OS	2.20511
NASHVILLE INTL	KBNA	TN	2.47699
NASHVILLE INTL	KBNA	TN	2.43699
NATRONA CO INTL (CASPER)	KCPR	WY	3.93257
NATRONA CO INTL (CASPER)	KCPR	WY	3.98257
NEW CENTURY AIRCENTER (OLATHE)	KIXD	KS	2.7953
NEWPORT NEWS WILLIAMSBURG INTL	KPHF	VA	3.587035
NIAGARA FALLS INTL	KIAG	NY	3.4684
NIAGARA FALLS INTL	KIAG	NY	3.4684
NINOY AQUINO INTL (COL JESUS A VILLAMOR AB)	RPLL	OS	2.2224
NOGALES INTL	KOLS	AZ	3.1818
NOME	PAOM	AK	0
NORMAN Y MINETA SAN JOSE INTL	KSJC	CA	0
NORMAN Y MINETA SAN JOSE INTL	KSJC	CA	0
NORTH CENTRAL WEST VIRGINIA	KCKB	WV	4.7704
NORTH CENTRAL WEST VIRGINIA	KCKB	WV	4.6704
NORTH PLATTE/REGIONAL NE.	KLBF	NE	3.925
NORTHWEST ARKANSAS RGNL	KXNA	AR	3.01479
NOUAKCHOTT (AD)	GQNN	OS	0

NURNBERG	EDDN	OS	2.40863
N'WAMENA	FTTJ	OS	3.950443
N'WAMENA	FTTJ	OS	3.950443
O R TAMBO INTL	FAJS	OS	0
O R TAMBO INTL	FAJS	OS	2.2631
ODESSA INTL	UKOO	OS	0
OKECIE	EPWA	OS	0
ONTARIO INTL	KONT	CA	2.620126
ONTARIO INTL	KONT	CA	2.670126
OPA LOCKA	KOPF	FL	3.874382
ORANJESTAD/REINA BEATFRIX IAP	TNCA	OS	0
ORANJESTAD/REINA BEATFRIX IAP	TNCA	OS	0
ORLANDO INTL	KMCO	FL	3.606424
ORLANDO INTL	KMCO	FL	3.556424
OUAGADOUGOU (AD)	DFFD	OS	3.158048
OUAGADOUGOU (AD)	DFFD	OS	3.158048
OWENSBORO DAVIESS CO	KOWB	KY	3.43674
PAGE MUNI	KPGA	AZ	3.568
PAGO PAGO INTL	NSTU	OS	2.5436
PALM BEACH INTL	KPBI	FL	3.59795
PALM BEACH INTL	KPBI	FL	3.55795
PALM SPRINGS INTL	KPSP	CA	2.476699
PALM SPRINGS INTL	KPSP	CA	2.426699
PANAMA CITY BAY CO INTL (formally KPFN)	KECP	FL	3.802986
PANAMA CITY BAY CO INTL (formally KPFN)	KECP	FL	3.732986
PANAMA CITY/TOCUMEN INTL	MPTO	OS	2.3371
PASO ROBLES MUNI	KPRB	CA	3.4365
PASO ROBLES MUNI	KPRB	CA	3.3865
PAYA LEBAR	WSAP	OS	2.78499
PECOS MUNI	KPEQ	TX	3.1858
PENSACOLA RGNL	KPNS	FL	4.071914
PENSACOLA RGNL	KPNS	FL	4.031914
PHOENIX SKY HARBOR INTL	KPHX	AZ	2.9475
PHUKET IAP	VTSP	OS	2.545
PIEDMONT TRIAD INTL (GREENSBORO)	KGSO	NC	4.02073
PIEDMONT TRIAD INTL (GREENSBORO)	KGSO	NC	4.07073
PINAL AIRPARK (MARANA)	KMZJ	AZ	2.751
PINAL AIRPARK (MARANA)	KMZJ	AZ	2.691
PISA (MIL)	LIRP	OS	2.8104
PLOVDIV	LBPD	OS	0

PLOVDIV	LBPD	OS	2.78469
POCATELLO RGNL	KPIH	ID	3.532145
PONCA CITY REGIONAL	KPNC	OK	3.2743
PONCE/MERCEDITA	TJPS	OS	0
PONCE/MERCEDITA	TJPS	OS	0
PORT COLUMBUS INTL	KCMH	OH	3.7274
PORT MORESBY INTL	AYPY	OS	0
PORT-AU-PRINCE IAP	MTPP	OS	0
PORTLAND HILLSBORO	KHIO	OR	2.4507
PORTLAND HILLSBORO	KHIO	OR	2.4007
PORTLAND INTL	KPDX	OR	3.1597
PORTLAND INTL	KPDX	OR	3.1097
PORT-OF-SPAIN/PIARCO INTL	TTPP	OS	2.5079
PORTSMOUTH INTL AT PEASE	KPSM	NH	3.994282
PORTSMOUTH INTL AT PEASE	KPSM	NH	4.024282
PRAGUE/RUZYNE	LKPR	OS	2.26866
PRESIDENTE JUSCELINO KUBITSCHEK INTL (BRASILIA IAP)	SBBR	OS	3.4018
PRESQUE ISLE/NORTHERN MAINE RAPT	KPQI	ME	4.0565
PRESQUE ISLE/NORTHERN MAINE RAPT	KPQI	ME	4.0015
PRESTWICK	EGPK	OS	2.474
PRISTINA	LYPR	OS	3.2995
PROVIDENCIALES	MBPV	OS	0
PROVIDENCIALES	MBPV	OS	0
PUCALLPA APT	SPCL	OS	0
PUEBLO MEM	KPUB	CO	3.2615
QUAD CITY INTL	KMLI	IL	3.9066
QUEEN ALIA	OJAI	OS	0
QUITO/MARISCAL SUCRE	SEQU	OS	0
QUONSET STATE	KOQU	RI	4.481
RABAT SALE INTL	GMME	OS	2.4545
RABAT SALE INTL	GMME	OS	2.4545
RALEIGH DURHAM INTL	KRDU	NC	3.8874
RALEIGH DURHAM INTL	KRDU	NC	3.9374
RAYONG/UTAPAO INTL	VTBU	OS	2.645
READING RGNL CARL A SPAATZ FLD	KRDG	PA	4.0889
REDDING MUNI	KRDD	CA	3.2205
RENO STEAD	K4SD	NV	0
RENO TAHOE INTL	KRNO	NV	2.939519
RENO TAHOE INTL	KRNO	NV	2.989519
REPUBLIC (FARMINGDALE)	KFRG	NY	3.927115

REYKJAVIK	BIRK	OS	0
RICHARD LLOYD JONES JR AIRPORT TULSA	KRVS	OK	2.6612
RICHARD LLOYD JONES JR AIRPORT TULSA	KRVS	OK	0.05
RICHARD LLOYD JONES JR AIRPORT TULSA	KRVS	OK	0.05
RICHMOND INTL	KRIC	VA	4.186004
RICHMOND INTL	KRIC	VA	4.146004
RICK HUSBAND AMARILLO INTL	KAMA	TX	3.00669
RICKENBACKER INTL (COLUMBUS)	KLCK	OH	3.6641
RICKENBACKER INTL (COLUMBUS)	KLCK	OH	3.7141
RIGA APT	EVRA	OS	2.41075
RIO DE JANEIRO IAP	SBGL	OS	3.1867
Riyadh Mil Apt Saudi A	OERY	OS	2.5587
Riyadh Mil Apt Saudi A	OERY	OS	2.5396
ROANOKE RGNLWOODRUM FLD	KROA	VA	4.479
ROANOKE RGNLWOODRUM FLD	KROA	VA	4.429
ROATAN APT	MHRO	OS	2.7663
ROBERTS FLD	KRDM	OR	0
ROBERTS FLD	KRDM	OR	0
ROCKY MOUNTAIN METROPOLITAN (DENVER)	KBJC	CO	3.5436
ROGUE VALLEY INTL MEDFORD	KMFR	OR	2.8095
ROGUE VALLEY INTL MEDFORD	KMFR	OR	2.7495
ROME/GRIFFISS AFB N.Y.	KRME	NY	4.456905
ROME/GRIFFISS AFB N.Y.	KRME	NY	4.416905
ROSWELL INTL AIR CENTER	KROW	NM	3.59
ROSWELL INTL AIR CENTER	KROW	NM	3.22
SACRAMENTO MATHER	KMHR	CA	3.364506
SACRAMENTO MATHER	KMHR	CA	3.314506
SALINA MUNI	KSLN	KS	3.2886
SALINAS/MUNI CA.	KSNS	CA	0
SALINAS/MUNI CA.	KSNS	CA	0
SALT LAKE CITY INTL	KSLC	UT	2.5375
SALT LAKE CITY INTL	KSLC	UT	2.5775
SAN ANGELO RGNL MATHIS FLD	KSJT	TX	2.70099
SAN ANTONIO INTL	KSAT	TX	2.51829
SAN BERNARDINO INTL	KSBD	CA	0
SAN DIEGO INTL	KSAN	CA	0
SAN DIEGO INTL	KSAN	CA	0
SAN FRANCISCO INTL	KSFO	CA	0
SAN FRANCISCO INTL	KSFO	CA	0
SAN JUAN/FERN LUIS RIBAS APT	TJIG	OS	4.442905

SAN JUAN/FERN LUIS RIBAS APT	TJIG	OS	4.292905
SAN JUAN/LUIS MUNOZ MARIN APT	TJSJ	OS	2.7642
SAN JUAN/LUIS MUNOZ MARIN APT	TJSJ	OS	3.9071
SAN PEDRO SULA/LA MESA INTL	MHLM	OS	2.4956
SAN SALVADOR/EL SALVADOR INTL	MSLP	OS	2.5388
SANFORD	KSFB	FL	3.963605
SANTA BARBARA MUNI	KSBA	CA	2.791525
SANTA BARBARA MUNI	KSBA	CA	2.851525
SANTA CRUZ/VIRU VIRU INTL	SLVR	OS	0
SANTA FE MUNI	KSAF	NM	3.3568
SANTA MARIA PUB CPT G ALLAN HANCOCK	KSMX	CA	3.083976
SANTA TERESA DONA ANA CO	K5T6	NM	3.2087
SANTIAGO/ARTURA MERINO BENITZ	SCEL	OS	2.4667
SANTO DOMINGO/DE LAS AMERICAS INTL	MDSD	OS	0
SARAJEVO INTL	LQSA	OS	0
SARASOTA BRADENTON INTL	KSRQ	FL	3.6907
SAVANNAH HILTON HEAD INTL	KSAV	GA	3.657205
SAVANNAH HILTON HEAD INTL	KSAV	GA	3.757205
SAWYER INTL	KSAW	MI	3.47114
SCOTT AFB MIDAMERICA	KBLV	IL	2.71979
SCOTT AFB MIDAMERICA	KBLV	IL	2.71979
SCOTTSDALE	KSDL	AZ	3.3109
SCOTTSDALE	KSDL	AZ	3.2609
SEATTLE TACOMA INTL	KSEA	WA	0
SEATTLE TACOMA INTL	KSEA	WA	0
SENOU	GABS	OS	3.684691
SENOU	GABS	OS	3.684691
SEYCHELLES INTL	FSIA	OS	0
SEYCHELLES INTL	FSIA	OS	3.247
SHANNON	EINN	OS	2.25075
Sharm El Sheikh Intl	HESH	OS	2.555
SHREVEPORT RGNL	KSHV	LA	3.0602
SIAULIAI INTL	EYSA	OS	0
SIKESTON MEM MUNI	KSIK	MO	3.85828
SINGAPORE CHANGI INTL	WSSS	OS	2.2032
SIR SEEWOOSAGUR RAMGOOLAN INTL	FIMP	OS	2.3583
SIR SEEWOOSAGUR RAMGOOLAN INTL	FIMP	OS	2.3583
SKOPJE	LWSK	OS	3.32453
SKYLARK FLD	KILE	TX	2.87329
SMYRNA (SEWART)	KMQY	TN	2.51235

SNOHOMISH CO (PAINE FLD)	KPAE	WA	3.1095
SNOHOMISH CO (PAINE FLD)	KPAE	WA	3.0595
SOFIA	LBSF	OS	2.78469
SOUTH ALABAMA RGNL AT BILL BENTON FLD	K79J	AL	3.369
SOUTH ALABAMA RGNL AT BILL BENTON FLD	K79J	AL	3.369
SOUTH BIG HORN COUNTY	KGEY	WY	3.4899
SOUTH CAPITOL STREET AIRPORT	K09W	DC	0
SOUTHEAST TEXAS RGNL (BEAUMONT PORT ARTHUR)	KBPT	TX	2.74299
SOUTHERN CALIFORNIA LOGISTICS (VICTORVILLE)	KVCV	CA	3.1216
SOUTHERN CALIFORNIA LOGISTICS (VICTORVILLE)	KVCV	CA	3.1416
SOUTHWEST GEORGIA RGNL (ALBANY)	KABY	GA	4.4808
SPIRIT OF ST LOUIS	KSUS	MO	3.38874
SPOKANE INTL	KGEG	WA	0
SPOKANE INTL	KGEG	WA	2.861905
SPOKANE INTL	KGEG	WA	2.811905
ST AUGUSTINE	KSGJ	FL	4.335784
ST LOUIS DOWNTOWN	KCPS	IL	3.39919
ST LUCIE CO INTL	KFPR	FL	4.07993
ST PETERSBURG CLEARWATER INTL	KPIE	FL	3.653219
ST PETERSBURG CLEARWATER INTL	KPIE	FL	3.723219
ST. CROIX/HENRY E. ROHLSEN APT	TISX	OS	4.2308
ST. THOMAS/CYRIL E. KING APT	TIST	OS	3.9667
ST.JOHNS/V.C.BIRD IAP	TAPA	OS	0
STAFFORD RGNL	KRMN	VA	4.742505
STAFFORD RGNL	KRMN	VA	4.692505
STANSTED	EGSS	OS	2.14065
STENNIS INTL	KHSA	MS	3.1387
STENNIS INTL	KHSA	MS	3.0887
STEWART INTL (NEWBURGH)	KSWF	NY	3.949905
STILLWATER RGNL	KSWO	OK	3.1146
STINSON MUNI	KSSF	TX	3.3774
STOCKTON/STOCKTON METROPOLITAN CALIF.	KSCK	CA	0
STRACHOWICE	EPWR	OS	0
STUTTGART	EDDS	OS	2.46363
STUTTGART	EDDS	OS	2.82363
SUBIC BAY INTL	RPLB	OS	0
SUBIC BAY INTL	RPLB	OS	2.679988
SULTAN ABDUL AZIZ SHAH INTL (KUALA LUMPUR)	WMSA	OS	2.47299
SYDNEY INTL (KINGSFORD SMITH)	YSSY	OS	2.4285
SYRACUSE HANCOCK INTL	KSYR	NY	3.606605

TABUK	OETB	OS	2.6538
TALLAHASSEE RGNL	KTLH	FL	4.277669
TAMPA INTL	KTPA	FL	4.006688
TAMPERE-PIRKKALA	EFTP	OS	0
TBILISI	UGTB	OS	2.55508
TED STEVENS ANCHORAGE INTL	PANC	AK	2.05788
TED STEVENS ANCHORAGE INTL	PANC	AK	2.17488
TED STEVENS ANCHORAGE INTL	PANC	AK	2.12488
TEGEL	EDDT	OS	2.293
TEGUCIGALPA/TONCONTIN INTL	MHTG	OS	2.5205
TERRE HAUTE INTL HULMAN FLD	KHUF	IN	3.16769
TETERBORO	KTEB	NJ	4.3551
TETERBORO	KTEB	NJ	4.4151
TEXARKANA RGNL WEBB FLD	KTXK	AR	3.00789
THE EASTERN IOWA (CEDAR RAPIDS)	KCID	IA	4.315
THE EASTERN IOWA (CEDAR RAPIDS)	KCID	IA	4.365
TIRANA RINAS INT'L	LATI	OS	3.2995
TOLEDO EXPRESS	KTOL	OH	3.7921
TOLEDO EXPRESS	KTOL	OH	3.8521
TORREJON	LETO	OS	2.309
TRI CITIES	KPSC	WA	2.399405
TRI CITIES	KPSC	WA	2.319405
TRI STATE MILTON J FERGUSON FLD	KHTS	WV	3.818805
TRI STATE MILTON J FERGUSON FLD	KHTS	WV	3.888805
TROY MUNI	KTOI	AL	0
TROY MUNI	KTOI	AL	3.4018
TSTC WACO	KCNW	TX	2.9957
TUCSON INTL	KTUS	AZ	2.7929
TULSA INTL	KTUL	OK	2.6205
TULSA INTL	KTUL	OK	2.6805
TUPELO RGNL	KTUP	MS	3.05908
TUSCALOOSA RGNL	KTCL	AL	2.9942
TYLER POUNDS RGNL	KTYR	TX	2.88079
UDON THANI APT	VTUD	OS	2.695
UDON THANI APT	VTUD	OS	2.645
UNIVERSITY OF OKLAHOMA WESTHEIMER	KOUN	OK	3.0701
UPPER CUMBERLAND RGNL	KSRB	TN	0
VAERNES	ENVA	OS	0
VALDOSTA RGNL	KVLD	GA	4.591915
VALENCIA	LEVC	OS	2.304

VALLEY INTL	KHRL	TX	3.0353
VALLEY INTL	KHRL	TX	3.0853
VAN NUYS	KVNY	CA	2.5364
VARNA	LBWN	OS	2.81958
VICKSBURG TALLULAH RGNL	KTVR	LA	2.9642
VICTORIA RGNL	KVCT	TX	2.2433
VILLAFRANCA (MIL)	LIPX	OS	2.8004
VILNIUS INTL	EYVI	OS	0
W K KELLOGG (BATTLE CREEK)	KBTL	MI	3.47974
WACO RGNL	KACT	TX	3.1549
WACO RGNL	KACT	TX	3.25589
WALNUT RIDGE RGNL	KARG	AR	2.6255
WASHINGTON DULLES INTL	KIAD	DC	3.85997
WASHINGTON DULLES INTL	KIAD	DC	3.85997
WAUKEGAN RGNL	KUGN	IL	3.48949
WAYNESVILLE ST ROBERT RGNL	KTBN	MO	0
WAYNESVILLE ST ROBERT RGNL	KTBN	MO	0
WENDOVER (DECKER AAF)	KENV	UT	2.739435
WENDOVER (DECKER AAF)	KENV	UT	2.789435
WICHITA MID CONTINENT	KICT	KS	3.07644
WICHITA MID CONTINENT	KICT	KS	3.04644
WIEN/SCHWECHAT	LOWW	OS	2.28266
WILEY POST	KPWA	OK	2.8404
WILKES BARRE SCRANTON INTL	KAVP	PA	4.191405
WILKES BARRE SCRANTON INTL	KAVP	PA	4.256405
WILL ROGERS WORLD	KOKC	OK	2.9347
WILL ROGERS WORLD	KOKC	OK	2.8947
WILLIAM P HOBBY	KHOU	TX	4.3438
WILLIAMS GATEWAY (PHOENIX)	KIWA	AZ	3.4496
WILLIAMS GATEWAY (PHOENIX)	KIWA	AZ	3.4896
WILLIAMSON CO RGNL	KMWA	IL	0
WILLIAMSON CO RGNL	KMWA	IL	2.997455
WILMINGTON INTL	KILM	NC	4.5574
WILMINGTON INTL	KILM	NC	4.5624
WINDER BARROW	KWDR	GA	4.662715
WINDHOEK/LUGHAWE	FYWH	OS	0
WITTMAN RGNL (OSHKOSH)	KOSH	WI	3.25519
YAKIMA AIR TERMINAL MC ALLISTER FLD	KYKM	WA	2.8369
YAOUNDE/NSIMALEN	FKYS	OS	3.020543
YAOUNDE/NSIMALEN	FKYS	OS	3.020543

YEAGER (CHARLESTON)	KCRW	WV	4.4902
YEAGER (CHARLESTON)	KCRW	WV	4.5402
YUMA MCAS YUMA INTL	KNYL	AZ	2.906
YUMA MCAS YUMA INTL	KNYL	AZ	2.856
Zagreb IAP Croatia	LDZA	OS	2.4295
ZAMBOANGA INTL	RPMZ	OS	3.105
ZAMBOANGA INTL	RPMZ	OS	3.205

APPENDIX C: Non Contract Fuel Locations

CYHZ	KGVT	RKSM
CYJT	KMKE	SGAS
CYQX	KMLB	SMJP
CYYT	KOXR	TNCC
KABE	KPHL	VABB
KACY	KPVD	VRMM
KALB	KPVU	VVNB
KBBG	KRAP	VVTS
KBOS	KSGF	WMKK
KBWI	KSUA	ZBAA
KCEF	KVUJ	
KCEW	LDZD	
KDBQ	MMMX	
KEWR	OMAA	
KFFC	PTRO	

APPENDIX D: Historical Data of Selected Flights

ACMDS	Dep ICAO	Price at Dep	Arr ICAO	Price at Arr	Fly Time Pnd	Fuel and Cargo Weight Planned (1000s)	Max Allowed to Tanker	Maximum Savings	True Savings (Based on Lower of Planned Fuel on Next Mission or Max Allowed to Tankered)
C017A	UAFM	3.03	OAKB	6.5	1.9	80	228500	$ 98,924.28	
C017A	OAKB	6.5	OAIX	3.03	0.3	115	193500		$ 19,033.68
C005A	OAIX	3.03	OAKN	6.5	0.8	168.8	200200	$ 94,033.58	
C005A	OAKN	6.5	ORAA	3.03	4.4	276.2	92800		$ 84,398.54
C017A	OAIX	3.03	OAKN	6.5	1	140.1	168400	$ 79,317.40	
C017A	OAKN	6.5	OTBH	3.03	3	94.6	213900		$ 41,757.86
C017A	UAFM	3.03	OAKB	6.5	1.6	134	174500	$ 77,760.92	
C017A	OAKB	6.5	UAFM	3.03	1.6	156	152500		$ 43,840.03
C017A	OAIX	3.03	OAKB	6.5	0.1	164	144500	$ 73,562.47	
C017A	OAKB	6.5	UAFM	3.03	1.6	156	152500		$ 49,088.78
C017A	OAIX	3.03	OAKN	6.5	1	160.8	147700	$ 69,567.57	
C017A	OAKN	6.5	OTBH	3.03	3	104.8	203700		$ 43,929.66
C017A	OAIX	3.03	OAZI	6.5	1	162	146500	$ 69,002.37	
C017A	OAZI	6.5	OTBH	3.03	3	83.4	225100		$ 36,229.63
C017A	OTBH	3.03	OAKB	6.5	3	130	178500	$ 68,970.71	
C017A	OAKB	6.5	OAIX	3.03	0.1	167.2	141300		$ 44,143.18
C017A	OTBH	3.03	OAKN	6.5	2.3	144.4	164100	$ 68,266.57	
C017A	OAKN	6.5	OTBH	3.03	0	93	215500		$ 43,519.65
C017A	OADY	3.03	OAKB	6.5	0.9	168.6	139900	$ 66,485.61	
C017A	OAKB	6.5	UAFM	3.03	1.6	146	162500		$ 42,618.50
C017A	OAIX	3.03	OAZI	6.5	0.9	173.1	135400	$ 64,347.05	
C017A	OAZI	6.5	OTBH	3.03	3	97.5	211000		$ 43,361.84
C017A	ORTL	3.03	OAKN	6.5	3.4	144.3	164200	$ 60,666.56	
C017A	OAKN	6.5	OTBH	3.03	2.7	84	224500		$ 35,700.73
C017A	UAFM	3.03	OAKN	6.5	2.3	166.4	142100	$ 59,114.44	
C017A	OAKN	6.5	OKAS	3.03	3.5	116.4	192100		$ 40,431.16
C017A	OTBH	3.03	OAZI	6.5	2.7	164.2	144300	$ 57,587.65	
C017A	OAZI	6.5	OMAM	3.03	2.6	170.2	138300		$ 41,497.82
C017A	UAFM	3.03	OAKB	6.5	1.6	180.4	128100	$ 57,084.09	
C017A	OAKB	6.5	UAFM	3.03	1.6	156.4	152100		$ 46,441.53

C017A	OTBH	3.03	OAKN	6.5	2.5	170	138500	$ 56,444.90	
C017A	OAKN	6.5	OTBH	3.03	3.3	143	165500		$ 45,936.88
C017A	UAFM	3.03	OAKB	6.5	1.6	182	126500	$ 56,371.09	
C017A	OAKB	6.5	UAFM	3.03	1.6	153	155500		$ 44,803.55
C017A	UAFM	3.03	OAKB	6.5	1.7	180.9	127600	$ 56,321.43	
C017A	OAKB	6.5	UAFM	3.03	1.5	143.2	165300		$ 39,438.44
C017A	UAFM	3.03	OAKB	6.5	1.7	185	123500	$ 54,511.73	
C017A	OAKB	6.5	UAFM	3.03	1.6	139	169500		$ 37,903.12
C017A	UAFM	3.03	OAKB	6.5	1.6	191.8	116700	$ 52,004.01	
C017A	OAKB	6.5	UAFM	3.03	1.6	156.6	151900		$ 41,720.29
C017A	UAFM	3.03	OAZI	6.5	2.2	187.2	121300	$ 50,974.71	
C017A	OAZI	6.5	FJDG	3.03	6.2	196.5	112000		$ 50,974.71
C017A	UAFM	3.03	OAKB	6.5	1.6	196.2	112300	$ 50,043.27	
C017A	OAKB	6.5	OAIX	3.03	1.6	162	146500		$ 49,139.38
C017A	OTBH	3.03	OAKN	6.5	2.4	190.9	117600	$ 48,424.76	
C017A	OAKN	6.5	OAIX	3.03	0.7	168.4	140100		$ 48,424.76
C017A	OAIX	3.03	OAKB	6.5	4.1	169.4	139100	$ 47,273.42	
C017A	OAKB	6.5	OAKN	6.5	0.8	111.4	197100		$ 43,850.82
C017A	OKAS	3.03	OAKN	6.5	3	188.7	119800	$ 46,289.59	
C017A	OAKN	6.5	OTBH	3.03	2.9	105.5	203000		$ 34,288.17
C017A	OTBH	3.03	OAKN	6.5	2.4	199.6	108900	$ 44,842.31	
C017A	OAKN	6.5	OAZI	6.5	0.3	164.5	144000		$ 44,842.31
C017A	OTBH	3.03	OAKN	6.5	2.4	200	108500	$ 44,677.60	
C017A	OAKN	6.5	OTBH	3.03	3.7	154	154500		$ 44,677.60
C017A	UAFM	3.03	OAKN	6.5	2.3	202	106500	$ 44,304.63	
C017A	OAKN	6.5	OAHR	3.03	0.7	153.3	155200		$ 44,304.63
C017A	OAIX	3.03	OAKN	6.5	0.8	216.6	91900	$ 44,063.06	
C017A	OAKN	6.5	OOTH	3.03	2.9	83.6	224900		$ 36,618.66
C017A	OKAS	3.03	OAKN	6.5	3	199.3	109200	$ 42,193.85	
C017A	OAKN	6.5	OKAS	3.03	3.5	151.4	157100		$ 43,779.86
C017A	OKAS	3.03	OAKN	6.5	3.1	198.9	109600	$ 41,884.71	
C017A	OAKN	6.5	OTBH	3.03	2.7	91.4	217100		$ 36,807.11
C017A	UAFM	3.03	OAKN	6.5	2.3	210	98500	$ 40,976.58	
C017A	OAKN	6.5	OKAS	3.03	3.6	165	143500		$ 40,976.58
C017A	UAFM	3.03	OAKN	6.5	2.4	209	99500	$ 40,971.63	
C017A	OAKN	6.5	OKAS	3.03	3.5	157.6	150900		$ 40,971.63
C017A	UAFM	3.03	OAZI	6.5	2.4	209.6	98900	$ 40,724.56	
C017A	OAZI	6.5	UAFM	3.03	2.4	161.5	147000		$ 40,724.56
C017A	OKBK	3.46	OAZI	6.5	3.1	180.9	127600	$ 40,647.02	
C017A	OAZI	6.5	OTBH	3.03	3	89.4	219100		$ 30,163.26

C017A	UAFM	3.03	OAKN	6.5	2.2	212.6	95900	$ 40,300.70	
C017A	OAKN	6.5	OKAS	3.03	3.6	164.4	144100		$ 40,300.70
C017A	UAFM	3.03	OAKN	6.5	2.3	212.3	96200	$ 40,019.77	
C017A	OAKN	6.5	OKAS	3.03	3.6	169.6	138900		$ 40,019.77
C017A	UAFM	3.03	OAKN	6.5	2.2	215.2	93300	$ 39,208.08	
C017A	OAKN	6.5	OKAS	3.03	3.5	164.3	144200		$ 39,208.08
C017A	UAFM	3.03	OAKN	6.5	2.3	215.4	93100	$ 38,730.15	
C017A	OAKN	6.5	OKAS	3.03	3.5	154.2	154300		$ 38,730.15
C017A	OAIX	3.03	OAKN	6.5	0.8	227.8	80700	$ 38,693.02	
C017A	OAKN	6.5	OTBH	3.03	2.9	137.9	170600		$ 38,693.02
C017A	UAFM	3.03	OAZI	6.5	2.4	217.4	91100	$ 37,512.72	
C017A	OAZI	6.5	OASH	3.03	0.7	160.8	147700		$ 37,512.72
C017A	OBBI	3.46	OAZI	6.5	2.6	198.8	109700	$ 37,265.54	
C017A	OAZI	6.5	OTBH	3.03	3	107	201500		$ 34,030.08
C017A	UAFM	3.03	OAKN	6.5	2.3	219.8	88700	$ 36,899.72	
C017A	OAKN	6.5	OKAS	3.03	3.7	174.2	134300		$ 36,899.72
C017A	UAFM	3.03	OAKN	6.5	2.3	222.2	86300	$ 35,901.31	
C017A	OAKN	6.5	OKAS	3.03	3.5	168.8	139700		$ 35,901.31
C017A	UAFM	3.03	OAKN	6.5	2.4	221.4	87100	$ 35,865.62	
C017A	OAKN	6.5	OKAS	3.03	3.7	170.2	138300		$ 35,865.62
C017A	UAFM	3.03	OAZI	6.5	2.4	222.6	85900	$ 35,371.49	
C017A	OAZI	6.5	UAFM	3.03	2.4	176	132500		$ 35,371.49
C017A	OKAS	3.03	OAKN	6.5	2.8	221.9	86600	$ 34,194.19	
C017A	OAKN	6.5	UAFM	3.03	2.2	161.2	147300		$ 34,194.19
C017A	OKAS	3.03	OAZI	6.5	3.2	219.6	88900	$ 33,597.89	
C017A	OAZI	6.5	OAKN	6.5	0.5	137.9	170600		$ 33,597.89
C017A	OTBH	3.03	OAZI	6.5	2.6	225.3	83200	$ 33,555.69	
C017A	OAZI	6.5	OTBH	3.03	2.9	82.5	226000		$ 33,497.66
C017A	OKAS	3.03	OAKN	6.5	2.9	223.2	85300	$ 33,320.00	
C017A	OAKN	6.5	UAFM	3.03	2.2	159.6	148900		$ 33,320.00
C017A	OKAS	3.03	OAKN	6.5	3	223.8	84700	$ 32,727.28	
C017A	OAKN	6.5	OADY	3.03	0.3	166.4	142100		$ 32,727.28
C017A	OKAS	3.03	OAKN	6.5	3	225.4	83100	$ 32,109.05	
C017A	OAKN	6.5	UAFM	3.03	2.1	160	148500		$ 32,109.05
C017A	UAFM	3.03	OAKN	6.5	2.2	234	74500	$ 31,307.63	
C017A	OAKN	6.5	OKAS	3.03	3.4	186.4	122100		$ 31,307.63
C017A	OKAS	3.03	OAKN	6.5	2.9	229.3	79200	$ 30,937.21	
C017A	OAKN	6.5	UAFM	3.03	2.2	168.2	140300		$ 30,937.21
C017A	UAFM	3.03	OAKN	6.5	2.3	235	73500	$ 30,576.43	
C017A	OAKN	6.5	OKAS	3.03	3.6	180	128500		$ 30,576.43

C017A	OTBH	3.03	OAKB	6.5	2.5	234.2	74300	$ 30,280.55	
C017A	OAKB	6.5	OTBH	3.03	3.4	110	198500		$ 30,280.55
C017A	OOTH	3.03	OAKN	6.5	2.7	232.7	75800	$ 30,250.48	
C017A	OAKN	6.5	OOTH	3.03	2.8	74.2	234300		$ 30,250.48
C017A	OKAS	3.03	OAKN	6.5	2.9	232.2	76300	$ 29,804.41	
C017A	OAKN	6.5	UAFM	3.03	2.3	164.2	144300		$ 29,804.41
C017A	OKAS	3.03	OAZI	6.5	3.3	229	79500	$ 29,709.01	
C017A	OAZI	6.5	OAKN	6.5	0.3	152.1	156400		$ 29,709.01
C017A	OKAS	3.03	OAKN	6.5	3	232.7	75800	$ 29,288.40	
C017A	OAKN	6.5	UAFM	3.03	2.2	158.5	150000		$ 29,288.40
C017A	OTBH	3.03	OAKB	6.5	2.9	235	73500	$ 28,710.67	
C017A	OAKB	6.5	OAIX	3.03	0.1	161.4	147100		$ 28,710.67
C017A	OTBH	3.03	OAKN	6.5	2.4	239	69500	$ 28,618.37	
C017A	OAKN	6.5	OTBH	3.03	2.8	120.5	188000		$ 28,618.37
C017A	OKBK	3.46	OAZI	6.5	3.1	219	89500	$ 28,510.25	
C017A	OAZI	6.5	OTBH	3.03	3.1	108.7	199800		$ 28,510.25
C017A	OKBK	3.46	OAKN	6.5	3.3	217.1	91400	$ 28,342.11	
C017A	OAKN	6.5	OTBH	3.03	3.1	103.2	205300		$ 28,342.11
C017A	OOTH	3.03	OAKN	6.5	2.7	238.1	70400	$ 28,095.43	
C017A	OAKN	6.5	OOTH	3.03	2.8	91	217500		$ 28,095.43
C017A	OTBH	3.03	OAKN	6.5	2.4	240.6	67900	$ 27,959.53	
C017A	OAKN	6.5	OAMS	3.03	0.9	162	146500		$ 27,959.53
C017A	OKAS	3.03	OAKN	6.5	3	237	71500	$ 27,626.92	
C017A	OAKN	6.5	UAFM	3.03	2.3	172	136500		$ 27,626.92
C017A	OKAS	3.03	OAKN	6.5	2.9	238.6	69900	$ 27,304.43	
C017A	OAKN	6.5	OTBH	3.03	2.9	104.7	203800		$ 27,304.43
C130H	OAFR	3.03	OAKN	6.5	1.1	14	56000	$ 26,968.64	
C130H	OAKN	6.5	OASD	3.03	1.1	29	41000		$ 14,457.14
C017A	SKBO	3.46	SKAP	4.27	0.5	55	253500	$ 26,852.25	
C017A	SKAP	4.27	SKBO	3.46	0.5	105	203500		$ 4,342.49
C017A	OKAS	3.03	OAKN	6.5	3	239.8	68700	$ 26,545.03	
C017A	OAKN	6.5	UAFM	3.03	2.2	172.4	136100		$ 26,545.03
C130H	OACC	3.03	OAKB	6.5	1.1	15	55000	$ 26,487.06	
C130H	OAKB	6.5	OAIX	3.03	0.4	11	59000		$ 5,483.74
C130H	OADY	3.03	OAKN	6.5	0.6	17.5	52500	$ 26,040.31	
C130H	OAKN	6.5	OAFR	3.03	1.1	30	40000		$ 13,641.63
C017A	OTBH	3.03	OAKN	6.5	2.5	245	63500	$ 25,879.07	
C017A	OAKN	6.5	OTBH	3.03	3.7	111	197500		$ 25,879.07
C130H	OADY	3.03	OAZI	6.5	0.6	18	52000	$ 25,792.31	
C130H	OAZI	6.5	OAKN	6.5	0.7	35	35000		$ 15,157.37

C130H	OADY	3.03	OAKN	6.5	0.5	19	51000	$ 25,443.42	
C130H	OAKN	6.5	OATN	3.03	0.6	38	32000		$ 11,144.99
C130H	OADY	3.03	OAKN	6.5	0.5	19	51000	$ 25,443.42	
C130H	OAKN	6.5	OAZI	6.5	0.7	51	19000		$ 13,171.35
C017A	SKBO	3.46	SKTI	4.27	0.3	85.9	222600	$ 24,816.48	
C017A	SKTI	4.27	SKBO	3.46	0.4	62.1	246400		$ 6,783.98
C130H	OADY	3.03	OAKN	6.5	0.7	20	50000	$ 24,656.07	
C130H	OAKN	6.5	OAMS	3.03	1.3	51	19000		$ 15,117.03
C130H	OATN	3.03	OAKN	6.5	0.5	21	49000	$ 24,445.64	
C130H	OAKN	6.5	OASD	3.03	1.1	47	23000		$ 13,677.94
KC010A	LICZ	3.03	LEZG	4.27	3.3	140.3	269700	$ 24,342.11	
KC010A	LEZG	4.27	LERT	3.03	1.1	116.5	293500		$ 6,628.26
C017A	OKAS	3.03	OAKN	6.5	2.9	246.4	62100	$ 24,257.58	
C017A	OAKN	6.5	UAFM	3.03	2.2	181.6	126900		$ 24,257.58
C130H	OAIX	3.03	OAKN	6.5	1.1	20	50000	$ 24,079.14	
C130H	OAKN	6.5	OAIX	3.03	1.3	53	17000		$ 12,463.05
C017A	OTBH	3.03	OAZI	6.5	2.6	249	59500	$ 23,997.16	
C017A	OAZI	6.5	OTBH	3.03	3	94.5	214000		$ 23,997.16
C130H	OADY	3.03	OAZI	6.5	0.4	22.5	47500	$ 23,834.32	
C130H	OAZI	6.5	OAKN	6.5	0.7	22	48000		$ 9,650.76
C130H	OASD	3.03	OAKN	6.5	1.1	21	49000	$ 23,597.56	
C130H	OAKN	6.5	OAIX	3.03	1.3	36	34000		$ 17,946.80
C017A	OOTH	3.03	OAKN	6.5	2.7	250.6	57900	$ 23,106.90	
C017A	OAKN	6.5	OOTH	3.03	2.8	79.4	229100		$ 23,106.90
C130H	OAJL	3.03	OAKB	6.5	0.5	24	46000	$ 22,948.96	
C130H	OAKB	6.5	OAIX	3.03	0.5	11	59000		$ 5,572.49
C130H	OAFR	3.03	OAKN	6.5	0.9	23	47000	$ 22,905.55	
C130H	OAKN	6.5	UAFM	3.03	3.5	40	30000		$ 18,043.62
C017A	OOTH	3.03	OAKN	6.5	2.7	251.2	57300	$ 22,867.45	
C017A	OAKN	6.5	OTBH	3.03	2.8	84.6	223900		$ 22,867.45
C130H	OATN	3.03	OAKN	6.5	1	23	47000	$ 22,769.97	
C130H	OAKN	6.5	OAZI	6.5	0.7	34	36000		$ 13,996.27
C130H	OAFR	3.03	OAKN	6.5	1	24	46000	$ 22,285.50	
C130H	OAKN	6.5	OAZI	6.5	1	42	28000		$ 12,996.54
C130H	OAHR	3.03	OAKB	6.5	1.5	23	47000	$ 22,092.09	
C130H	OAKB	6.5	OAMS	3.03	0.7	28	42000		$ 12,328.59
C130H	OATN	3.03	OAKN	6.5	0.4	26	44000	$ 22,078.11	
C130H	OAKN	6.5	OAIX	3.03	1.2	30	40000		$ 9,142.83
C130H	OADY	3.03	OAZI	6.5	0.5	26	44000	$ 21,951.18	
C130H	OAZI	6.5	OAKN	6.5	0.5	40	30000		$ 10,638.39

C130H	OASD	3.03	OAKN	6.5	1	25	45000	$ 21,801.04	
C130H	OAKN	6.5	OAZI	6.5	0.7	30	40000		$ 13,496.41
C130H	OAIX	3.03	OAKN	6.5	1.1	25	45000	$ 21,671.23	
C130H	OAKN	6.5	OAZI	6.5	0.7	38	32000		$ 12,961.58
C017A	OOTH	3.03	OAKN	6.5	2.7	254.4	54100	$ 21,590.38	
C017A	OAKN	6.5	OOTH	3.03	2.8	81	227500		$ 21,590.38
C017A	OOTH	3.03	OAKN	6.5	2.7	254.6	53900	$ 21,510.57	
C017A	OAKN	6.5	OTBH	3.03	2.7	110.2	198300		$ 21,510.57
C130H	OAIX	3.03	OAKN	6.5	1.2	26	44000	$ 21,062.72	
C130H	OAKN	6.5	OAZI	6.5	0.6	51	19000		$ 13,423.79
C017A	OOTH	3.03	OAKN	6.5	2.7	255.9	52600	$ 20,991.76	
C017A	OAKN	6.5	OOTH	3.03	2.8	80.1	228400		$ 20,991.76
C130H	OAIX	3.03	OAKB	6.5	0.4	29	41000	$ 20,572.78	
C130H	OAKB	6.5	OAIX	3.03	0.4	23	47000		$ 8,126.96
C017A	OOTH	3.03	OAKN	6.5	2.7	257.1	51400	$ 20,512.86	
C017A	OAKN	6.5	OOTH	3.03	2.8	86.2	222300		$ 20,512.86
C017A	LTAG	3.03	OAZI	6.5	5.2	240.1	68400	$ 20,062.65	
C017A	OAZI	6.5	LTAG	3.03	4.6	99.2	209300		$ 20,062.65
C017A	OOTH	3.03	OAKN	6.5	2.6	259.9	48600	$ 19,601.04	
C017A	OAKN	6.5	OOTH	3.03	2.9	86.1	222400		$ 19,601.04
C017A	OKBK	3.46	OAZI	6.5	3	248.1	60400	$ 19,495.98	
C017A	OAZI	6.5	OTBH	3.03	3.1	92.6	215900		$ 19,495.98
C130H	OAMS	3.03	OAKN	6.5	1.5	29	41000	$ 19,271.82	
C130H	OAKN	6.5	OAKB	6.5	1.1	20.1	49900		$ 9,862.87
C130H	OAMS	3.03	OAKB	6.5	1	31	39000	$ 18,894.23	
C130H	OAKB	6.5	OAKN	6.5	1.2	21	49000		$ 10,497.20
C017A	OKBK	3.46	OAKN	6.5	2.9	250.8	57700	$ 18,868.58	
C017A	OAKN	6.5	OTBH	3.03	3.5	162.6	145900		$ 18,868.58
C017A	OOTH	3.03	OAKN	6.5	2.5	262.5	46000	$ 18,747.04	
C017A	OAKN	6.5	OOTH	3.03	3	86.6	221900		$ 18,747.04
C130H	OASD	3.03	OAKN	6.5	0.9	32	38000	$ 18,519.38	
C130H	OAKN	6.5	UAFM	3.03	3.2	38	32000		$ 18,519.38
C130H	OASD	3.03	OAKN	6.5	1	32	38000	$ 18,409.76	
C130H	OAKN	6.5	OATN	3.03	0.5	36	34000		$ 12,496.67
C130H	OAIX	3.03	OAZI	6.5	1.3	32	38000	$ 18,080.92	
C130H	OAZI	6.5	OAHR	3.03	0.7	39	31000		$ 11,404.16
C017A	OKAS	3.03	OAZI	6.5	3.1	262.3	46200	$ 17,655.78	
C017A	OAZI	6.5	OTBH	3.03	3	111.2	197300		$ 17,655.78
C017A	OKAS	3.03	OAZI	6.5	3.3	262.5	46000	$ 17,190.12	
C017A	OAZI	6.5	OTBH	3.03	3	131.4	177100		$ 17,190.12

C130H	OADY	3.03	OAKN	6.5	0.4	36	34000	$ 17,060.36	
C130H	OAKN	6.5	OAZI	6.5	0.8	36	34000		$ 14,730.11
C130H	OAIX	3.03	OAKN	6.5	1.2	35	35000	$ 16,754.44	
C130H	OAKN	6.5	OAJL	3.03	1.2	41	29000		$ 8,452.02
C130H	OAIX	3.03	OAKN	6.5	1.2	35	35000	$ 16,754.44	
C130H	OAKN	6.5	OAZI	6.5	0.7	17	53000		$ 7,457.66
C130H	OAIX	3.03	OAKN	6.5	1.3	35	35000	$ 16,653.48	
C130H	OAKN	6.5	OAIX	3.03	1.1	28	42000		$ 9,420.82
C017A	LTAG	3.03	OAKN	6.5	5.4	251	57500	$ 16,378.99	
C017A	OAKN	6.5	LTAG	3.03	5.8	130.4	178100		$ 16,378.99
C017A	LTAG	3.03	OAZI	6.5	5.1	253.6	54900	$ 16,335.19	
C017A	OAZI	6.5	LTAG	3.03	4.9	136.8	171700		$ 16,335.19
C017A	OTBH	3.03	OAKN	6.5	2.3	269.3	39200	$ 16,307.43	
C017A	OAKN	6.5	OAMS	3.03	0.9	197.8	110700		$ 16,307.43
C130H	OAIX	3.03	OAKB	6.5	0.4	38	32000	$ 16,056.80	
C130H	OAKB	6.5	OAIX	3.03	0.3	22	48000		$ 10,158.70
C017A	LTAG	3.03	OAZI	6.5	5.2	254.2	54300	$ 15,926.93	
C017A	OAZI	6.5	LTAG	3.03	4.6	95.4	213100		$ 15,926.93
C130H	OAIX	3.03	OAZI	6.5	1.4	37.5	32500	$ 15,370.19	
C130H	OAZI	6.5	UAFM	3.03	3.3	50	20000		$ 14,340.16
C017A	LTAG	3.03	OAZI	6.5	5.3	255.7	52800	$ 15,263.57	
C017A	OAZI	6.5	LTAG	3.03	4.7	134.6	173900		$ 15,263.57
C130H	UAFM	3.03	OAKN	6.5	3.3	34	36000	$ 15,052.37	
C130H	OAKN	6.5	OASD	3.03	1	37	33000		$ 12,661.36
C130H	OAIX	3.03	OAKN	6.5	1.4	39	31000	$ 14,660.80	
C130H	OAKN	6.5	OASA	3.03	0.7	33	37000		$ 10,878.74
C017A	OTBH	3.03	OBBI	3.46	0.4	47.2	261300	$ 14,267.29	
C017A	OBBI	3.46	OTBH	3.03	2.7	210.4	98100		$ 8,436.12
C017A	OPRN	3.46	OP12	4.27	1.5	126.1	182400	$ 14,251.48	
C017A	OP12	4.27	OPRN	3.46	1.3	71.2	237300		$ 4,405.32
C017A	OKBK	3.46	OAKN	6.5	2.9	265	43500	$ 14,225.01	
C017A	OAKN	6.5	OTBH	3.03	3	101	207500		$ 14,225.01
C017A	LTAG	3.03	OAZI	6.5	5.3	259.9	48600	$ 14,049.43	
C017A	OAZI	6.5	LTAG	3.03	4.9	111.9	196600		$ 14,049.43
C130H	OAIX	3.03	OAKN	6.5	2.3	40	30000	$ 13,409.02	
C130H	OAKN	6.5	OATN	3.03	0.6	30	40000		$ 8,682.95
C130H	OAIX	3.03	OAZI	6.5	1.4	42	28000	$ 13,242.01	
C130H	OAZI	6.5	OAKN	6.5	0.7	33	37000		$ 8,406.30
C130H	OASD	3.03	OAKN	6.5	1	43	27000	$ 13,080.62	
C130H	OAKN	6.5	OADY	3.03	0.5	31	39000		$ 13,080.62

C017A	OTBH	3.03	OAKN	6.5	2.3	277.1	31400	$ 13,062.59	
C017A	OAKN	6.5	OTBH	3.03	1	51	257500		$ 13,062.59
C017A	YBAS	3.46	YSRI	4.27	2.2	92.2	216300	$ 12,692.07	
C017A	YSRI	4.27	PHIK	3.03	10	231.1	77400		$ 12,692.07
C130H	OAIX	3.03	OAKN	6.5	2.7	41	29000	$ 12,627.44	
C130H	OAKN	6.5	OAFR	3.03	1.1	40	30000		$ 12,627.44
C017A	OKBK	3.46	OAKN	6.5	2.9	270	38500	$ 12,589.96	
C017A	OAKN	6.5	OTBH	3.03	2.8	155	153500		$ 12,589.96
C017A	LTAG	3.03	OAKN	6.5	5.3	265	43500	$ 12,575.10	
C017A	OAKN	6.5	LTAG	3.03	4.8	109.6	198900		$ 12,575.10
C130H	OAIX	3.03	OAKB	6.5	0.5	45	25000	$ 12,472.26	
C130H	OAKB	6.5	OAHR	3.03	1.7	29	41000		$ 12,472.26
C017A	ETAR	3.03	OAZI	6.5	6.8	254.7	53800	$ 12,138.43	
C017A	OAZI	6.5	OTBH	3.03	2.9	125.2	183300		$ 12,138.43
C017A	LTAG	3.03	OAKN	6.5	5	268.4	40100	$ 12,101.18	
C017A	OAKN	6.5	LTAG	3.03	6.2	135.6	172900		$ 12,101.18
C017A	KADW	3.03	KJFK	3.46	0.6	68.6	239900	$ 12,018.28	
C017A	KJFK	3.46	KADW	3.03	0.6	88.6	219900		$ 2,516.33
C017A	OKBK	3.46	OAKN	6.5	3.1	272	36500	$ 11,627.09	
C017A	OAKN	6.5	OTBH	3.03	2.8	152.5	156000		$ 11,627.09
C017A	LTAG	3.03	OAKN	6.5	5.2	268.9	39600	$ 11,615.22	
C017A	OAKN	6.5	LTAG	3.03	5.3	99.4	209100		$ 11,615.22
C017A	KHUA	3.03	CYQX	4.27	3.7	168	140500	$ 11,324.05	
C017A	CYQX	4.27	ETAR	3.03	5.8	190	118500		$ 11,324.05
C017A	ORAA	3.03	ORBI	3.46	0.6	83.4	225100	$ 11,276.84	
C017A	ORBI	3.46	ORAA	3.03	0.4	112.5	196000		$ 3,158.36
C017A	LTAG	3.03	OAZI	6.5	5.4	269.3	39200	$ 11,166.20	
C017A	OAZI	6.5	LTAG	3.03	4.7	102.8	205700		$ 11,166.20
C017A	ORAA	3.03	ORBI	3.46	0.6	94.9	213600	$ 10,700.73	
C017A	ORBI	3.46	ORAA	3.03	0.3	132.4	176100		$ 3,903.94
C017A	ORAA	3.03	ORBI	3.46	0.4	118	190500	$ 10,401.53	
C017A	ORBI	3.46	ORAA	3.03	0.4	120	188500		$ 3,844.73
C017A	LTAG	3.03	OAZI	6.5	5.2	273.1	35400	$ 10,383.30	
C017A	OAZI	6.5	LTAG	3.03	4.8	110.8	197700		$ 10,383.30
C017A	YBAS	3.46	YSRI	4.27	2.4	113.8	194700	$ 10,342.37	
C017A	YSRI	4.27	YAMB	4.27	0.9	152.1	156400		$ 7,892.73
C017A	OKBK	3.46	OAZI	6.5	3.2	275.9	32600	$ 10,246.82	
C017A	OAZI	6.5	OTBH	3.03	2.9	88.6	219900		$ 10,246.82
C017A	ORMM	3.03	ORBI	3.46	0.8	87.9	220600	$ 10,057.79	
C017A	ORBI	3.46	ORAA	3.03	0.6	108.4	200100		$ 2,984.71

C017A	ORAA	3.03	ORBI	3.46	0.6	107.9	200600	$ 10,049.47	
C017A	ORBI	3.46	OKAS	3.03	0.9	111.3	197200		$ 2,138.36
C005B	KSUU	3.03	KLAX	3.46	1.1	54.5	314500	$ 9,965.36	
C005B	KLAX	3.46	KXMR	3.03	4.6	295.1	73900		$ 7,811.72
C017A	LTAG	3.03	OAKN	6.5	4.9	276	32500	$ 9,945.19	
C017A	OAKN	6.5	LTAG	3.03	6.5	130.6	177900		$ 9,945.19
C017A	LTAG	3.03	OAKN	6.5	4.8	276.8	31700	$ 9,834.50	
C017A	OAKN	6.5	LTAG	3.03	5.3	100.2	208300		$ 9,834.50
C130H	UAFM	3.03	OAKB	6.5	3.3	47	23000	$ 9,616.79	
C130H	OAKB	6.5	OAIX	3.03	1.4	13	57000		$ 6,096.21
KC010A	KWRI	3.03	KSDF	3.46	1.6	55	355000	$ 9,586.09	
KC010A	KSDF	3.46	PAED	3.03	6.6	213.8	196200		$ 4,379.48
C017A	ORMM	3.03	ORBI	3.46	0.8	98.8	209700	$ 9,560.83	
C017A	ORBI	3.46	ORAA	3.03	0.5	123.1	185400		$ 3,850.47
C130H	OAIX	3.03	OAKN	6.5	1.4	50	20000	$ 9,458.58	
C130H	OAKN	6.5	OAIX	3.03	1.7	43	27000		$ 9,458.58
C017A	OTBH	3.03	OBBI	3.46	0.4	140	168500	$ 9,200.30	
C017A	OBBI	3.46	OADY	3.03	2.5	181.4	127100		$ 7,321.70
C017A	KNKX	3.03	KDAG	3.46	0.5	132.9	175600	$ 9,192.50	
C017A	KDAG	3.46	KADW	3.03	4.3	117.1	191400		$ 5,218.98
C017A	KRIV	3.03	KIWA	3.46	1	90.8	217700	$ 8,945.02	
C017A	KIWA	3.46	KLSV	3.03	1	73.2	235300		$ 3,045.80
C017A	LTAG	3.03	OAKN	6.5	5	278.9	29600	$ 8,932.54	
C017A	OAKN	6.5	LTAG	3.03	6.3	140	168500		$ 8,932.54
C017A	ORAA	3.03	ORBI	3.46	0.5	138.2	170300	$ 8,915.05	
C017A	ORBI	3.46	ORAA	3.03	0.4	119.6	188900		$ 3,251.79
C017A	LTAG	3.03	OAKN	6.5	5.1	278.6	29900	$ 8,896.58	
C017A	OAKN	6.5	LTAG	3.03	5.8	137.7	170800		$ 8,896.58
C017A	KRIV	3.03	KIWA	3.46	1	92.6	215900	$ 8,871.06	
C017A	KIWA	3.46	KLSV	3.03	1.1	79.6	228900		$ 3,116.02
C005A	LICZ	3.03	OAKN	6.5	6.1	320	49000	$ 8,856.57	
C005A	OAKN	6.5	OAIX	3.03	1	75	294000		$ 8,856.57
C017A	ORAA	3.03	ORBI	3.46	0.5	139.4	169100	$ 8,852.23	
C017A	ORBI	3.46	OKAS	3.03	0.9	114.8	193700		$ 2,945.42
C017A	ORBD	3.03	ORBI	3.46	0.3	154.7	153800	$ 8,744.03	
C017A	ORBI	3.46	ETAR	3.03	5.1	169	139500		$ 8,019.31
C017A	LTAG	3.03	OAZI	6.5	5.3	278.3	30200	$ 8,730.30	
C017A	OAZI	6.5	LTAG	3.03	4.7	130.4	178100		$ 8,730.30
C017A	KRIV	3.03	KIWA	3.46	1	96.1	212400	$ 8,727.25	
C017A	KIWA	3.46	KLSV	3.03	0.8	74.1	234400		$ 3,159.91

C017A	KRIV	3.03	KIWA	3.46	1	99.6	208900	$ 8,583.44	
C017A	KIWA	3.46	KLSV	3.03	1	76.7	231800		$ 3,203.79
C017A	KADW	3.03	KGSO	3.46	0.7	130	178500	$ 8,540.33	
C017A	KGSO	3.46	KADW	3.03	0.6	124	184500		$ 2,440.40
C017A	OKBK	3.46	OAKN	6.5	3.2	282	26500	$ 8,329.47	
C017A	OAKN	6.5	OTBH	3.03	2.7	100.2	208300		$ 8,329.47
C017A	OTBH	3.03	OYSN	4.27	3.2	221.8	86700	$ 8,192.69	
C017A	OYSN	4.27	OTBH	3.03	3.1	92	216500		$ 8,192.69
C017A	OKAS	3.03	ORBI	3.46	1	109.2	199300	$ 8,188.99	
C017A	ORBI	3.46	OKAS	3.03	0.9	115.4	193100		$ 1,992.50
C130H	OTBH	3.03	OAKB	6.5	5	49	21000	$ 7,750.74	
C130H	OAKB	6.5	OAKN	6.5	1.3	30	40000		$ 8,029.44
C017A	OTBH	3.03	OKBK	3.46	0.9	130	178500	$ 7,736.34	
C017A	OKBK	3.46	OTBH	3.03	0.9	77.2	231300		$ 3,081.78
C017A	OTBH	3.03	OKBK	3.46	0.9	130	178500	$ 7,736.34	
C017A	OKBK	3.46	OTBH	3.03	3.2	297.1	11400		$ 7,342.15
C017A	OKAS	3.03	ORBI	3.46	1	120.8	187700	$ 7,712.36	
C017A	ORBI	3.46	ORAA	3.03	0.3	129.2	179300		$ 3,800.66
C017A	LTAG	3.03	OAKN	6.5	5.1	282.6	25900	$ 7,706.40	
C017A	OAKN	6.5	LTAG	3.03	6.5	122.4	186100		$ 7,706.40
C130H	KMSP	3.03	KEAU	4.27	0.5	26	44000	$ 7,654.11	
C130H	KEAU	4.27	KMSP	3.03	0.7	20	50000		$ 3,534.17
C017A	ORAA	3.03	OKBK	3.46	1.2	100	208500	$ 7,627.89	
C017A	OKBK	3.46	OKAS	3.03	0.2	35.4	273100		$ 1,214.27
C017A	OTBH	3.03	OKBK	3.46	0.9	135	173500	$ 7,519.63	
C017A	OKBK	3.46	OTBH	3.03	3.3	161	147500		$ 6,585.46
C017A	LTAG	3.03	OAKN	6.5	5.1	283.4	25100	$ 7,468.36	
C017A	OAKN	6.5	LTAG	3.03	5.8	123.5	185000		$ 7,468.36
C017A	OKBK	3.46	OAZI	6.5	3.2	285.2	23300	$ 7,323.64	
C017A	OAZI	6.5	OTBH	3.03	3	95	213500		$ 7,323.64
C017A	LTAG	3.03	OAKN	6.5	5.3	283.9	24600	$ 7,111.44	
C017A	OAKN	6.5	LTAG	3.03	5.8	132.7	175800		$ 7,111.44
C017A	OKAS	3.03	ORBI	3.46	1	136.4	172100	$ 7,071.38	
C017A	ORBI	3.46	OKAS	3.03	0.9	116.8	191700		$ 2,492.81
C017A	OKAS	3.03	ORBI	3.46	0.9	146.4	162100	$ 7,025.55	
C017A	ORBI	3.46	OKAS	3.03	1	126.8	181700		$ 2,834.13
C017A	LTAG	3.03	OAKN	6.5	5.2	285	23500	$ 6,892.87	
C017A	OAKN	6.5	LTAG	3.03	5.9	138.6	169900		$ 6,892.87
C130H	OTBH	3.03	OAKB	6.5	4.8	52	18000	$ 6,747.34	
C130H	OAKB	6.5	OAKN	6.5	1.3	20	50000		$ 6,747.34

C017A	ORBD	3.03	OKBK	3.46	1	144.7	163800	$ 6,730.34	
C017A	OKBK	3.46	ETAD	3.03	5.9	240	68500		$ 6,495.36
C017A	ORBD	3.03	LTAC	3.46	1.6	74	234500	$ 6,466.65	
C017A	LTAC	3.46	LTAG	3.03	0.7	52.1	256400		$ 1,349.49
C017A	LTAG	3.03	OAZI	6.5	5.2	286.6	21900	$ 6,423.57	
C017A	OAZI	6.5	LTAG	3.03	6.1	147.6	160900		$ 6,423.57
C017A	OKAS	3.03	ORBI	3.46	1	155	153500	$ 6,307.12	
C017A	ORBI	3.46	ORAA	3.03	0.4	130.4	178100		$ 3,633.89
C017A	LTAG	3.03	OAKN	6.5	5.2	287	21500	$ 6,306.24	
C017A	OAKN	6.5	LTAG	3.03	5.7	119.4	189100		$ 6,306.24
C017A	LTAG	3.03	OAKN	6.5	5.1	287.4	21100	$ 6,278.19	
C017A	OAKN	6.5	LTAG	3.03	5.8	135.9	172600		$ 6,278.19
C017A	LTAG	3.03	OAKN	6.5	5	288.2	20300	$ 6,126.04	
C017A	OAKN	6.5	LTAG	3.03	5.8	126.2	182300		$ 6,126.04
C130H	OTBH	3.03	OAKN	6.5	3.9	55	15000	$ 6,012.20	
C130H	OAKN	6.5	OAIX	3.03	1.3	21	49000		$ 6,012.20
C017A	OKAS	3.03	ORBI	3.46	0.9	170.6	137900	$ 5,976.70	
C017A	ORBI	3.46	ORAA	3.03	0.4	148.3	160200		$ 4,035.66
C017A	OKAS	3.03	ORBI	3.46	0.9	171.2	137300	$ 5,950.70	
C017A	ORBI	3.46	ORAA	3.03	0.4	151.2	157300		$ 4,182.41
C130H	KCRW	3.03	KCEW	4.27	2.2	30	40000	$ 5,669.70	
C130H	KCRW	3.03	KHIF	3.03	5.5	42.3	27700		$ 5,669.70
C017A	ETAR	3.03	OAKB	6.5	6.9	283	25500	$ 5,645.46	
C017A	OAKB	6.5	OAIX	3.03	0.1	86	222500		$ 5,645.46
C017A	OKAS	3.03	ORBI	3.46	1	171.4	137100	$ 5,633.27	
C017A	ORBI	3.46	OKAS	3.03	0.9	149.6	158900		$ 3,932.33
C130H	OTBH	3.03	OAKB	6.5	4.8	55	15000	$ 5,622.78	
C130H	OAKB	6.5	OAIX	3.03	0.3	18	52000		$ 5,622.78
C017A	OKBK	3.46	OAZI	6.5	3.2	291	17500	$ 5,500.59	
C017A	OAZI	6.5	OTBH	3.03	3.1	97	211500		$ 5,500.59
C130H	OTBH	3.03	OAKN	6.5	4.3	56	14000	$ 5,449.85	
C130H	OAKN	6.5	OTBH	3.03	3.9	43	27000		$ 5,449.85
C130J	ETAR	3.03	EPPW	4.27	2.2	32	38000	$ 5,386.22	
C130J	EPPW	4.27	ETAR	3.03	2.3	22	48000		$ 3,384.68
C017A	LTAG	3.03	OAZI	6.5	5.3	290	18500	$ 5,348.03	
C017A	OAZI	6.5	LTAG	3.03	4.9	132	176500		$ 5,348.03
C017A	LTAG	3.03	OAKN	6.5	4.8	291.4	17100	$ 5,305.05	
C017A	OAKN	6.5	LTAG	3.03	6.5	129.8	178700		$ 5,305.05
C017A	OKAS	3.03	ORBI	3.46	1	179.6	128900	$ 5,296.34	
C017A	ORBI	3.46	ORAA	3.03	0.5	154.1	154400		$ 4,274.65

C130H	KBGR	3.03	CYYT	4.27	2.6	30.7	39300	$ 5,272.59	
C130H	CYYT	4.27	EGPK	3.46	6.4	47.9	22100		$ 5,272.59
C017A	KDOV	3.03	KHSV	3.46	1.9	56	252500	$ 5,257.08	
C017A	KHSV	3.46	ETAR	3.03	10	264.6	43900		$ 5,870.57
C130J	KPOB	3.03	KHFF	4.27	2	34	36000	$ 5,239.17	
C130J	KHFF	4.27	KPOB	3.03	0.8	19	51000		$ 2,974.23
C017A	OTBH	3.03	OAZI	6.5	2.6	295.6	12900	$ 5,202.75	
C017A	OAZI	6.5	OTBH	3.03	3.1	97.3	211200		$ 5,202.75
C017A	OTBH	3.03	ORBI	3.46	1.7	111.4	197100	$ 4,991.41	
C017A	ORBI	3.46	ORAA	3.03	0.5	81.5	227000		$ 1,955.35
C130J	ETAR	3.03	EPPW	4.27	2.8	32	38000	$ 4,954.17	
C130J	EPPW	4.27	ETAR	3.03	1.9	30	40000		$ 4,373.43
C130H	OAIX	3.03	OPTA	4.27	1.3	39	31000	$ 4,922.72	
C130H	OPTA	4.27	OPRN	3.46	0.7	53	17000		$ 4,922.72
C130J	ETAR	3.03	EPPW	4.27	3.3	30	40000	$ 4,835.92	
C130J	EPPW	4.27	ETAR	3.03	1.7	30	40000		$ 4,171.73
C017A	LTAG	3.03	OAKN	6.5	5	292.6	15900	$ 4,798.22	
C017A	OAKN	6.5	LTAG	3.03	6.1	124.8	183700		$ 4,798.22
C017A	LTAG	3.03	OAKN	6.5	4.9	292.9	15600	$ 4,773.69	
C017A	OAKN	6.5	LTAG	3.03	6.2	141	167500		$ 4,773.69
C017A	LTAG	3.03	OAKN	6.5	5.3	292.6	15900	$ 4,596.42	
C017A	OAKN	6.5	LTAG	3.03	4.7	100.5	208000		$ 4,596.42
C130H	KDYS	3.03	KPVU	4.27	3.3	34	36000	$ 4,352.33	
C130H	KPVU	4.27	KDYS	3.03	2.3	32	38000		$ 4,449.85
C017A	KADW	3.03	KJAN	3.46	2	80.6	227900	$ 4,231.66	
C017A	KJAN	3.46	KADW	3.03	1.9	61.3	247200		$ 1,408.86
C130H	KDYS	3.03	KPVU	4.27	3.5	34	36000	$ 4,215.89	
C130H	KPVU	4.27	KDYS	3.03	3	30	40000		$ 4,091.05
C017A	LTAG	3.03	OAKN	6.5	5.1	295	13500	$ 4,016.85	
C017A	OAKN	6.5	LTAG	3.03	5.7	123	185500		$ 4,016.85
C017A	LTAG	3.03	OAKN	6.5	5.1	295	13500	$ 4,016.85	
C017A	OAKN	6.5	LTAG	3.03	5.8	139.6	168900		$ 4,016.85
C017A	LTAG	3.03	OAKN	6.5	5.1	295	13500	$ 4,016.85	
C017A	OAKN	6.5	LTAG	3.03	5.9	130.1	178400		$ 4,016.85
C017A	LTAG	3.03	OAKN	6.5	5.2	295	13500	$ 3,959.73	
C017A	OAKN	6.5	LTAG	3.03	5.7	151.6	156900		$ 3,959.73
C130H	KCRW	3.03	KCEW	4.27	2.3	42	28000	$ 3,915.73	
C130H	KCEW	4.27	KCRW	3.03	2	29	41000		$ 3,915.73
C017A	LTAG	3.03	OAZI	6.5	5.3	295.8	12700	$ 3,671.35	
C017A	OAZI	6.5	LTAG	3.03	4.7	118.3	190200		$ 3,671.35

C017A	LTAG	3.03	OAZI	6.5	5.3	296	12500	$ 3,613.54	
C017A	OAZI	6.5	LTAG	3.03	5.9	128.3	180200		$ 3,613.54
C130J	HDAM	3.46	HADR	4.27	0.6	38	32000	$ 3,470.49	
C130J	HADR	4.27	HUEN	3.46	2.9	33.5	36500		$ 3,470.49
C017A	KOFF	3.03	TNCC	4.27	5.4	205.6	102900	$ 3,431.75	
C017A	TNCC	4.27	KTCM	3.03	9.5	175.2	133300		$ 3,431.75
C017A	LTAG	3.03	OAKN	6.5	5.1	297	11500	$ 3,421.76	
C017A	OAKN	6.5	LTAG	3.03	5.8	127.2	181300		$ 3,421.76
C017A	LTAG	3.03	ORBI	3.46	1.8	167.6	140900	$ 3,250.87	
C017A	ORBI	3.46	LTAG	3.03	1.7	78.4	230100		$ 1,922.73
C017A	LTAG	3.03	ORBI	3.46	1.7	184.1	124400	$ 3,150.34	
C017A	ORBI	3.46	ORTL	3.03	0.7	102.1	206400		$ 2,244.14
C130E	ORMM	3.03	ORBI	3.46	1	21	49000	$ 3,041.62	
C130E	ORBI	3.46	ORAA	3.03	0.5	42	28000		$ 1,618.88
C130J	HKJK	3.46	HKM1	4.27	1.3	39	31000	$ 2,950.82	
C130J	HKM1	4.27	HKMO	3.46	0.9	23.8	46200		$ 1,597.78
C130E	ORMM	3.03	ORBI	3.46	1.1	23	47000	$ 2,910.26	
C130E	ORBI	3.46	ORBD	3.03	0.5	17	53000		$ 869.82
C130E	ORKK	3.03	ORBI	3.46	0.9	24	46000	$ 2,862.47	
C130E	ORBI	3.46	ORBD	3.03	0.5	19	51000		$ 935.99
C130E	ORSH	3.03	ORBI	3.46	0.4	25	45000	$ 2,834.79	
C130E	ORBI	3.46	ORBD	3.03	0.4	22	48000		$ 946.07
C130E	ORAA	3.03	ORBI	3.46	0.5	25	45000	$ 2,827.88	
C130E	ORBI	3.46	ORAA	3.03	0.5	38	32000		$ 1,321.68
C130H	KIAG	3.03	KAVP	3.46	0.7	17	53000	$ 2,801.63	
C130H	KAVP	3.46	KIAG	3.03	0.8	14	56000		$ 650.36
C130H	KNFW	3.03	KMWL	3.46	0.2	25	45000	$ 2,724.23	
C130H	KMWL	3.46	KNFW	3.03	0.3	22	48000		$ 1,340.24
C017A	UAFM	3.03	OPRN	3.46	2.1	143	165500	$ 2,700.29	
C017A	OPRN	3.46	UAFM	3.03	2.1	163.8	144700		$ 2,259.30
C017A	OTBH	3.03	ORBI	3.46	2.2	121.5	187000	$ 2,629.95	
C017A	ORBI	3.46	OKAS	3.03	1.1	115	193500		$ 1,617.70
C017A	ETAD	3.03	OAKN	6.5	6.8	296.9	11600	$ 2,617.21	
C017A	OAKN	6.5	OAIX	3.03	2.2	96.4	212100		$ 2,617.21
C017A	UAFM	3.03	OPRN	3.46	2.1	148.2	160300	$ 2,615.45	
C017A	OPRN	3.46	UAFM	3.03	2.1	191	117500		$ 2,241.54
C130E	ORBD	3.03	ORBI	3.46	0.4	29	41000	$ 2,582.81	
C130E	ORBI	3.46	ORAA	3.03	0.5	32	38000		$ 1,324.50
C130E	ORKK	3.03	ORBI	3.46	0.7	30	40000	$ 2,501.38	
C130E	ORBI	3.46	ORBD	3.03	0.3	18	52000		$ 877.35

C130E	ORKK	3.03	OKBK	3.46	1.7	30	40000	$ 2,439.96	
C130E	OKBK	3.46	ORBI	3.46	1.2	32	38000		$ 1,717.06
C130H	KMRB	3.03	KMGW	3.46	0.7	24.8	45200	$ 2,389.31	
C130H	KMGW	3.46	KCRW	3.03	0.6	21.6	48400		$ 1,116.45
C130E	ORTL	3.03	ORBI	3.46	0.7	32	38000	$ 2,376.32	
C130E	ORBI	3.46	ORBD	3.03	0.3	18	52000		$ 1,002.69
C130J	HKJK	3.46	HKM1	4.27	1.2	45.7	24300	$ 2,359.11	
C130J	HKM1	4.27	HKMO	3.46	0.8	21.6	48400		$ 1,622.34
C130H	OTBH	3.03	OYAA	4.27	4.5	46	24000	$ 2,355.80	
C130H	OYAA	4.27	OTBH	3.03	4.3	57	13000		$ 2,355.80
C130H	ORKK	3.03	ORBI	3.46	0.6	27	43000	$ 2,339.05	
C130H	ORBI	3.46	ORBD	3.03	0.5	49	21000		$ 1,777.33
C130E	ORAA	3.03	ORBI	3.46	0.5	33	37000	$ 2,325.14	
C130E	ORBI	3.46	ORAA	3.03	0.5	45	25000		$ 1,762.24
C130E	ORAA	3.03	ORBI	3.46	0.5	34	36000	$ 2,262.30	
C130E	ORBI	3.46	ORMM	3.03	1	35.4	34600		$ 1,636.37
C017A	LTAG	3.03	OAZI	6.5	5.4	300.6	7900	$ 2,250.33	
C017A	OAZI	6.5	LTAG	3.03	6.1	131.3	177200		$ 2,250.33
C130H	OKAS	3.03	OBBI	3.46	1	24	46000	$ 2,219.70	
C130H	OBBI	3.46	OTBH	3.03	0.7	27	43000		$ 852.77
C017A	KTCM	3.03	KMZJ	3.46	2.3	123.7	184800	$ 2,182.83	
C017A	KMZJ	3.46	KPOB	3.03	3.5	132	176500		$ 1,496.43
C130H	KRNO	3.03	KLAS	3.46	1.3	20	50000	$ 2,182.40	
C130H	KLAS	3.46	KRNO	3.03	1.4	32	38000		$ 922.57
KC135R	ETAR	3.03	LYPR	3.46	1.8	50.4	122100	$ 2,175.92	
KC135R	LYPR	3.46	ETAR	3.03	1.9	49.7	122800		$ 1,050.95
C130E	ORMM	3.03	ORBI	3.46	1.1	35	35000	$ 2,167.21	
C130E	ORBI	3.46	ORSH	3.03	0.5	24	46000		$ 1,366.87
C130J	KSKF	3.03	KAEX	3.46	1.1	24	46000	$ 2,149.07	
C130J	KAEX	3.46	KHOP	3.03	1.5	24.1	45900		$ 688.33
C130H	KCRW	3.03	KMGW	3.46	0.8	28.5	41500	$ 2,130.01	
C130H	KMGW	3.46	KMRB	3.03	0.5	25.3	44700		$ 1,284.31
C130E	ORBD	3.03	ORBI	3.46	0.4	37	33000	$ 2,078.84	
C130E	ORBI	3.46	LTAG	3.03	3.2	38	32000		$ 2,078.84
C130E	ORSH	3.03	ORBI	3.46	0.8	37	33000	$ 2,058.58	
C130E	ORBI	3.46	ORTL	3.03	0.8	34	36000		$ 1,625.88
C130E	ORBD	3.03	OKBK	3.46	1.5	36.7	33300	$ 2,041.50	
C130E	OKBK	3.46	ORBD	3.03	1.4	37	33000		$ 1,736.91
C130E	ORBD	3.03	ORBI	3.46	0.5	39	31000	$ 1,948.09	
C130E	ORBI	3.46	ORBD	3.03	0.5	34	36000		$ 1,948.09

C130H	KRNO	3.03	KLAS	3.46	1.5	23	47000	$ 1,907.12	
C130H	KLAS	3.46	KRNO	3.03	1.5	21	49000		$ 695.03
C130H	KMXF	3.03	KHSV	3.46	0.7	34	36000	$ 1,902.99	
C130H	KHSV	3.46	KMXF	3.03	0.7	25	45000		$ 1,354.92
C130H	KRNO	3.03	KLAS	3.46	1.2	28	42000	$ 1,897.70	
C130H	KLAS	3.46	KRNO	3.03	1.2	20	50000		$ 901.99
C130E	ORBD	3.03	ORBI	3.46	0.4	40.7	29300	$ 1,845.76	
C130E	ORBI	3.46	ORBD	3.03	0.3	34.1	35900		$ 1,845.76
C130H	ORBD	3.03	ORBI	3.46	0.4	38	32000	$ 1,838.96	
C130H	ORBI	3.46	OTBH	3.03	2.9	37	33000		$ 1,572.23
C130E	ORBD	3.03	ORBI	3.46	0.4	41	29000	$ 1,826.86	
C130E	ORBI	3.46	ORSH	3.03	0.5	38	32000		$ 1,826.86
C130E	ORTL	3.03	ORBI	3.46	0.8	41	29000	$ 1,809.05	
C130E	ORBI	3.46	ORBD	3.03	0.3	27	43000		$ 1,563.34
C130H	OTBH	3.03	OBBI	3.46	0.6	37	33000	$ 1,795.08	
C130H	OBBI	3.46	OTBH	3.03	3	45	25000		$ 1,795.08
C130H	ORBD	3.03	ORBI	3.46	0.5	38	32000	$ 1,789.82	
C130H	ORBI	3.46	OTBH	3.03	2.7	38	32000		$ 1,649.70
C130H	ORBD	3.03	ORBI	3.46	0.4	39	31000	$ 1,781.49	
C130H	ORBI	3.46	OTBH	3.03	2.5	36	34000		$ 1,688.69
C130H	OTBH	3.03	OBBI	3.46	0.5	39.6	30400	$ 1,700.33	
C130H	OBBI	3.46	OOTH	3.03	2.7	33	37000		$ 1,700.33
C130E	ORBD	3.03	ORBI	3.46	0.5	44	26000	$ 1,633.88	
C130E	ORBI	3.46	ORMM	3.03	1.3	41	29000		$ 1,633.88
C130H	KMXF	3.03	KHSV	3.46	1.5	30	40000	$ 1,623.08	
C130H	KHSV	3.46	KMXF	3.03	0.6	20	50000		$ 868.79
C130H	LPLA	3.03	CYYT	4.27	4.5	53.9	16100	$ 1,580.35	
C130H	CYYT	4.27	KFFO	3.03	5.6	51.5	18500		$ 1,580.35
C130J	KNTD	3.03	KCIC	3.46	1.4	33.1	36900	$ 1,553.95	
C130J	KCIC	3.46	KNTD	3.03	1.3	24.5	45500		$ 649.37
C130H	KPOB	3.03	KAGS	3.46	1	38.4	31600	$ 1,524.84	
C130H	KAGS	3.46	KLSF	3.03	1	29.8	40200		$ 1,319.28
KC135T	ETAR	3.03	LYPR	3.46	1.7	97.8	74700	$ 1,521.23	
KC135T	LYPR	3.46	ETAR	3.03	2	98.8	73700		$ 1,207.16
C130E	ORTL	3.03	ORBI	3.46	0.7	46	24000	$ 1,500.83	
C130E	ORBI	3.46	ORTL	3.03	0.8	26	44000		$ 1,500.83
C130H	OTBH	3.03	OYAA	4.27	4.4	55	15000	$ 1,500.80	
C130H	OYAA	4.27	OTBH	3.03	4.2	48	22000		$ 1,500.80
C130J	KNTD	3.03	KCIC	3.46	1.3	36.2	33800	$ 1,475.30	
C130J	KCIC	3.46	KNTD	3.03	1.3	28	42000		$ 1,291.60

C130E	ORBM	3.03	ORBI	3.46	0.8	46.6	23400	$ 1,459.72	
C130E	ORBI	3.46	ORBD	3.03	0.3	38	32000		$ 1,375.74
C130E	ORBD	3.03	ORBI	3.46	0.3	47	23000	$ 1,452.42	
C130E	ORBI	3.46	ORKK	3.03	0.7	42.5	27500		$ 1,452.42
C130E	ORBD	3.03	ORBI	3.46	0.4	47	23000	$ 1,448.89	
C130E	ORBI	3.46	ORAA	3.03	0.5	55	15000		$ 1,448.89
C130H	KMTC	3.03	KARR	3.46	1.4	36	34000	$ 1,431.82	
C130H	KARR	3.46	KFFO	3.03	1	31	39000		$ 1,074.82
C130E	ORBD	3.03	ORBI	3.46	0.5	48	22000	$ 1,382.52	
C130E	ORBI	3.46	OTBH	3.03	2.4	42	28000		$ 1,382.52
C130J	KBIX	3.03	KSAV	3.46	1.5	36	34000	$ 1,379.62	
C130J	KSAV	3.46	KBIX	3.03	1.9	28.5	41500		$ 1,216.30
C130H	KMTC	3.03	KARR	3.46	1.5	37.2	32800	$ 1,330.92	$ -
C130H	KARR	3.46	KFFO	3.03	1	25.6	44400		$ 999.11
C130H	LPLA	3.03	CYYT	4.27	4.5	57.4	12600	$ 1,236.79	
C130H	CYYT	4.27	KFFO	3.03	5.6	51.5	18500		$ 1,236.79
C130E	ORBD	3.03	ORBI	3.46	0.4	51	19000	$ 1,196.91	
C130E	ORBI	3.46	ORSH	3.03	0.5	49	21000		$ 1,196.91
C130H	ORKK	3.03	ORBI	3.46	0.9	46	24000	$ 1,194.96	
C130H	ORBI	3.46	ORBD	3.03	0.4	47	23000		$ 1,194.96
C130E	ORBD	3.03	ORBI	3.46	0.5	51	19000	$ 1,193.99	
C130E	ORBI	3.46	ORSH	3.03	0.4	45	25000		$ 1,193.99
C130E	ORBD	3.03	ORBI	3.46	0.3	52	18000	$ 1,136.68	
C130E	ORBI	3.46	ORSH	3.03	0.4	41	29000		$ 1,136.68
C017A	KCHS	3.03	TJSJ	3.46	2.5	170	138500	$ 1,012.12	
C017A	TJSJ	3.46	TGPY	4.27	20	40	268500		$ 286.09
C130H	KLRF	3.03	KGSO	3.46	2.1	38	32000	$ 1,003.64	
C130H	KGSO	3.46	KNYG	3.03	0.9	33.7	36300		$ 626.07
KC135R	ETAR	3.03	LYPR	3.46	1.8	117.8	54700	$ 974.80	
KC135R	LYPR	3.46	ETAR	3.03	1.9	98	74500		$ 1,083.87
C130H	KNYG	3.03	KGSO	3.46	0.9	50.7	19300	$ 960.95	
C130H	KGSO	3.46	KLRF	3.03	2.7	26.7	43300		$ 960.95
C017A	ETAD	3.03	CYQX	4.27	6.1	239.4	69100	$ 960.16	
C017A	CYQX	4.27	PAEI	3.03	7.2	259	49500		$ 960.16
C017A	OKAS	3.03	HECA	3.46	2.5	190	118500	$ 865.96	
C017A	HECA	3.46	OAIX	3.03	5.8	190.4	118100		$ 865.96
C130H	OTBH	3.03	ORBI	3.46	2.5	37.5	32500	$ 819.71	
C130H	ORBI	3.46	ORTL	3.03	0.7	32	38000		$ 809.80
C130H	OTBH	3.03	ORBI	3.46	2.6	39	31000	$ 734.28	
C130H	ORBI	3.46	OKAS	3.03	1.3	26	44000		$ 630.25

C130H	KADW	3.03	KOAJ	3.46	1.1	54.6	15400	$ 719.47	
C130H	KOAJ	3.46	KPOB	3.03	0.3	44.9	25100		$ 719.47
C130J	KBLV	3.03	KMHK	3.46	1.4	53	17000	$ 715.91	
C130J	KMHK	3.46	KGRK	3.03	1.7	42	28000		$ 715.91
C130H	EGUN	3.03	CYYT	4.27	7.3	55	15000	$ 676.49	
C130H	CYYT	4.27	KPIT	3.03	5.2	43	27000		$ 676.49
C130J	ETAR	3.03	EDDS	3.46	0.6	58.2	11800	$ 641.88	
C130J	EDDS	3.46	ETAR	3.03	5.2	73.9	-3900		$ 641.88
C017A	ETAR	3.03	CYQX	4.27	6.4	201	107500	$ 597.42	
C017A	CYQX	4.27	KGRF	3.03	8	220	88500		$ 597.42
C017A	OKAS	3.03	HECA	3.46	2.6	192.6	115900	$ 585.95	
C017A	HECA	3.46	OAIX	3.03	5.6	146.8	161700		$ 585.95
C130H	KYNG	3.03	KAGR	3.46	3	38	32000	$ 561.42	
C130H	KAGR	3.46	KYNG	3.03	3.4	38	32000		$ 561.42
C130H	OTBH	3.03	ORBI	3.46	2.5	52	18000	$ 453.99	
C130H	ORBI	3.46	ORBD	3.03	0.5	33	37000		$ 453.99
C130H	OMAM	3.03	ORBI	3.46	3	46	24000	$ 421.07	
C130H	ORBI	3.46	OTBH	3.03	2.5	39	31000		$ 421.07
C130H	OTBH	3.03	ORBI	3.46	2.7	53	17000	$ 376.57	
C130H	ORBI	3.46	ORKK	3.03	0.7	34	36000		$ 376.57
C130H	OTBH	3.03	ORBI	3.46	2.7	55	15000	$ 332.26	
C130H	ORBI	3.46	ORBD	3.03	0.4	49	21000		$ 332.26
C005A	LERT	3.03	OAKN	6.5	8.2	365	4000	$ 265.02	
C005A	OAKN	6.5	ORAA	3.03	4.5	215.6	153400		$ 265.02
C130J	LTAG	3.03	ORBI	3.46	2.5	59.9	10100	$ 254.74	
C130J	ORBI	3.46	LIRN	3.46	5.9	74	-4000		$ 254.74
C130J	LGSA	3.03	LLBG	3.46	1.7	66.2	3800	$ 142.52	
C130J	LLBG	3.46	LICZ	3.03	4.2	69.7	300		$ 142.52
C130H	KMFD	3.03	KCYS	3.46	3.9	36	34000	$ 126.64	
C130H	KCYS	3.46	KMFD	3.03	3	36	34000		$ 126.64
C017A	OKAS	3.03	HECA	3.46	2.8	182.9	125600	$ 69.27	
C017A	HECA	3.46	OKAS	3.03	2.3	58	250500		$ 444.57
C130J	LGSA	3.03	EDDS	3.46	3.9	56	14000	$ 52.15	
C130J	EDDS	3.46	ETAR	3.03	0.4	23	47000		$ 52.15
C130J	KMSP	3.03	CYYT	4.27	5.7	69.6	400	$ 30.17	
C130J	CYYT	4.27	KOKC	3.03	7.1	47.2	22800		$ 30.17
						Total		$ 5,392,799.40	$ 4,262,273.73

APPENDIX E Blue Dart

The USAF alone consumed approximately 2.5 billion gallons of aviation fuel in 2008, costing $7.56 billion. Secretary of the Air Force Michael B. Donley released Air Force Policy Memorandum 10-1 on June 16, 2009, in which he issued a mandate to limit fuel consumption: "the Air Force goal of reducing aviation fuel-use per hour of operation by 10% (from a 2006 base line) by 2015." The practice of tankering for cost avoidance is an important technique used by commercial air carriers to reduce their operating costs. Fuel tankering is a viable cost saving initiative that needs to be adopted within AMC, the USAF and the DoD.

Historical and theoretical research done in the field showed the potential for significant savings. Stroup and Wollmer's model was used by McDonnell Douglas and resulted in a savings of 5-6% with Brazilian airline Viacao Aerea Sao Paulo during short and medium range flights and savings were as high as 10.69% on specific flights. A study by Zouein, Abillama and Tohme covered all aircraft types in the Middle Eastern Airline (MEA) fleet and concluded that a 10% savings in fuel cost could be realized without a major investment on the part of the participating airline.

Current practices, models, and flight programming software used in the commercial sector were also examined, specifically with Atlas Air, Continental Airlines, FedEx and UPS. Important factors and guidelines were identified to define an AMC tankering program. An Excel model was developed to compare fuel costs of historical flights completed without tankering to the respective fuel costs of the same flights with tankering, and demonstrates potential tankering savings of $10 to $111 million per year for AMC. The model also enables AMC to determine if a planned flight should consider tankering, and if tankering is used, it estimates the total dollars saved in cost avoidance for that flight.

Reasons to tanker include:

- Lower priced fuel at departure location in comparison to destination including the cost to carry the extra fuel
- Unreliable fuel supply or fuel quality at the destination
- Ground time reduction (to meet ATC slot time), or losing money because the plane will sit on the ground to long

Reasons not to tanker include:

- Increased fuel burn because of greater weight increment and the speed increment increase to meet a given cost index
- Lower optimum & maximum cruise levels resulting in reduced efficiency (higher fuel burn rates)
- Increased thrust needed for takeoff (limits ability to accomplish derated or FLEX take-offs)
- Added wear & tear on the flaps, brakes, tires, and landing gear

These are factors AMC should consider in any tankering implementation program, focusing on overall safety and training while maximizing potential fuel cost savings.

- Never turn away cargo or passengers in order to tanker for cost savings
- Avoid planning or flying to airfields that have a higher fuel cost than the DoD standard price
- Plan missions backwards: final sortie first and first sortie last
- Do not tanker fuel beyond tank volume and/or mass capacity
- Do not tanker to maximum take-off weight
- Do not tanker to Max Landing Weight in order to prevent holding
- Do not tanker with maintenance issues
- Do not tanker so that weight exceeds that of maximum weight limits by departure airport, specific to each aircraft and airport
- Do not tanker to high and hot airfields
- Carefully consider not tankering on long flights (in excess of 5 to 6 hours)
- The tankering calculations should be automated
- If tankering is beneficial and the dispatcher decides not to tanker, justification should be annotated

- If dispatchers tanker when it is not profitable, justification should be annotated
- Do not tanker fuel when other mission objectives are a higher priority

The following are additional recommendations that should be considered if a tankering program is implemented.

- AMC must ensure that current crews practice flying and discuss the characteristics of flying a heavier aircraft associated with tankering fuel
- The USAF and AMC need to consider writing fuel efficiency and/or tanker mandates or guidelines into the contracts with the civilian contract carriers
- AMC should adopt even more of an airline model for adding fuel to a mission. If the commercial pilot wants to add fuel, the pilot must call the dispatcher who must obtain approval; then the dispatcher would call POL to add the fuel
- AMC must continue to establish fuel conservation and cost reduction policies

Tankering Fuel: A Cost Saving Initiative

Major Walter J. Lesinski III
Advisor: Alan Johnson, PhD
Advanced Studies of Air Mobility (ENS) -- Air Force Institute of Technology

Introduction

The practice of tankering for cost avoidance (purchasing fuel at a lower price point at departure to avoid paying higher prices at the destination) is an important technique used by commercial air carriers to reduce their operating costs

Tankering is a viable cost saving initiative that needs to be adopted within AMC, USAF, and DoD

Overall Objective: Determine if AMC would benefit if it adopts a tankering fuel for cost avoidance policy

Research Questions

-What is the theory behind tankering for cost avoidance?

-What tankering models and programs being used today in industry and how well do they work?

-What information is needed to create a real-time planning tool to make tankering decisions daily?

-What are the positives & negatives of implementing a tankering program?

-What factors do AMC need to consider and how much money would it save?

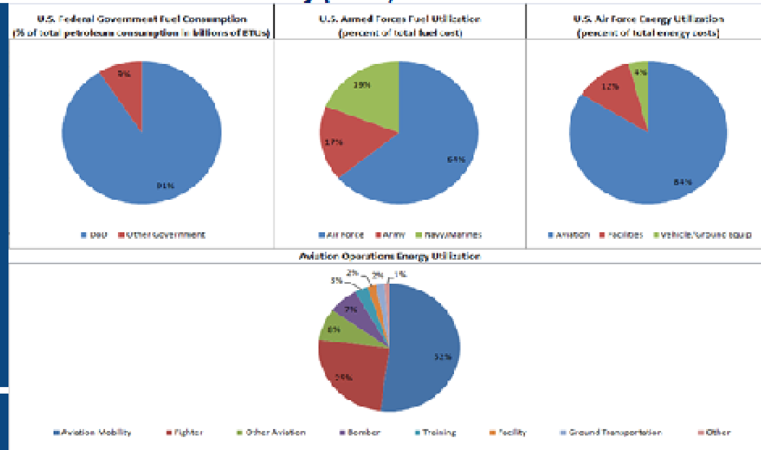

Figure 1 U.S. Federal Energy Consumption Snapshot: From the Federal Government to the Air Force

	AMC Tankering Model			
Enter Data in Blue Cells		Current Fuel Costs		
Departure Fuel Price $/gal	$3.03	DFSP, JP-8	$3.03	1-Oct-10
Tankered Fuel Load lbs	28316.80	Jet A (Into-Plane)	$3.46	1-Oct-10
Purchase Cost (departure)	$12,705.74	Jet A (Non Contract Source at Airport)	$4.27	1-Oct-10
Planned Flight Time Hours	8.1	NATO	$6.50	1-Oct-10
Cost to Carry lbs	10102.80			
Aircraft Cost to Carry	0.044	Cost to Carry		
Destination Fuel Price $/gal	$6.50	C-17	4.40%	0.0440
Tankered Fuel Remaining lbs	10244.00	C-5	5.67%	0.0567
Purchase Cost (destination)	$17,512.31	KC-135	4.97%	0.0497
Fuel Purchase Ratio	0.724	KC-10	4.47%	0.0447
Fuel Cost Ratio	0.466	C-130	3.00%	0.0300
Tankering Index	1.417			
Cost Avoidance/Savings (5% mx cost)	$4,594.74	Negative Means Money Lost		
Cost Avoidance/Savings (1% mx cost)	$4,700.20	Negative Means Money Lost		

Motivation: USAF consumed ~2.6 billion gallons of aviation fuel in 2008, costing $7.56 billion

AFPM10-1 16 June 2009, mandated "the Air Force goal of reducing aviation fuel-use per hour of operation by 10% (from a 2006 base line) by 2015"

Reasons to Tanker Fuel

- Cost savings
- Unreliable fuel supply or fuel quality at the destination
- Ground time reduction

Impact and Conclusion

- Potential savings of $10 million to $110 million annually
- Created Excel tool to be used by AMC planner
- 14 Rules to guide an AMC tankering program
- 4 Recommendations to implementing program

Collaboration

- AMC A3/EO, DLA, Atlas Air, Continental Airlines, FedEx and UPS

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14. ABSTRACT
The Practice of Tankering for Cost Avoidance is an important technique used by Commercial Air Carriers to reduce their Operating Costs. This paper identifies if it is important to consider tankering as a viable cost saving initiative within Air Mobility Command, the United States Air Force and the Department of Defense. It explores the history and theory of research done in the area as well as current practices, models, and flight programming software used in the commercial sector, specifically with Atlas Air, Continental Airlines, FedEx and UPS. It identifies the factors and guidelines that should define an Air Mobility tankering program. A simple model demonstrates potential savings of up to $111 million a year through analysis of historical data of flights completed without tanking and compares it to the costs that could have been saved if tankering was used. The model also allows for AMC to determine if a planned flight should consider tankering, and if tankering is used, it estimates the total dollars saved in cost avoidance for that flight. The paper also identifies positive and negative factors the Air Force would need to address if it implements such a program. The final section identifies factors AMC should consider in any tankering implementation program focusing on overall safety and training while maximizing potential savings.

15. SUBJECT TERMS
Tankering for Cost Avoidance, Cost to Carry, Cost of Weight, Tankering Program, Flight Planning

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