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contemporary issues

Analysis: KC-135 Lean Fueling Operations
Meeting the Army's Equipping Challenge

Contemporary Issues in this edition presents two articles: "Analysis: KC-135 Lean Fueling Operations" and "Meeting the Army's Equipping Challenge."

In "Analysis: KC-135 Lean Fueling Operations" Major Bruce P. Heseltine, USAF, outlines how the use of lean and just-in-time fueling procedures, coupled with the development of a tanker dispatch system, would enable the KC-135 community to markedly improve mission planning using a fixed targeted shutdown fuel quantity. Under this approach, aircraft would be loaded with only the fuel needed to accomplish a given mission, while significantly reducing unnecessary ferrying of fuel. The net result would be a decrease in the amount of fuel required (or purchased) each year. Further, the concepts and findings addressed in this article could be tailored to various Air Mobility Command (AMC) aircraft mission processes. AMC is the largest consumer of fuel in the DoD, and flew over 142,000 sorties in 2005. If $200 were saved on every sortie the command could save over $28M per year. While $28M is a significant amount of money, initial indications show the possibility of savings in excess of $160M per year through the application of major fuel efficiency initiatives across the command.

Colonel Jim Campbell, USA, in "Meeting the Army's Equipping Challenge" explores the United States Army's current equipping strategy, and suggests the modifications needed to help create conditions and metrics to assess current equipment requirements as well as requirements for the future. Campbell argues that first, it would be beneficial for the Army to modify readiness assessments of equipment required for mission accomplishment, and to develop metrics that more accurately reflect actual mission essential needs (including unit status report methodology). Second, a modified program similar to the Army Prepositioned Stock program is needed that is capable of rotational operations to facilitate the use of prepositioned equipment in current and future contingency operations. Finally, increased budgetary allocations specifically tied to achieving equipping strategies with improved acquisition programs and increased efficiency of the US industrial base will potentially increase the amount of military specific equipment available for use by soldiers. Alone, these measures will have a minor impact on the current situation, but taken collectively they provide a potential solution to overcome the current equipping dilemma facing the Army.

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Analysis: KC-135 Lean Fueling Operations

Bruce P. Heseltine, Jr, Major, USAF

Introduction

Over the past several years, fuel costs have risen dramatically. At the same time, United States Air Force Air Mobility Command (AMC) is facing some very significant challenges.

- Personnel cuts
- Engaging in the Global War on Terror
- Aggressively working to recapitalize its aging KC-135 tanker fleet
- Reduced budgets and ever-increasing oil prices
- Inefficient operational practices

Changes must be made to reduce consumption of fuel, while maintaining mission effectiveness. This paper addresses significant potential cost savings associated with the implementation of an aggressive *lean* fuel savings initiative in the KC-135 community.

Lean

It is important to lay the foundation of what is meant by a *lean fuel initiative*. Womack and Jones define the basic principals of Lean[1] as

- Specifying Value
- Identifying the Value Stream
- Flow
- Pull
- Perfection

The *Specific Value* of this fuel savings proposal is an enhanced, effective, mission planning and execution program that achieves greater efficiencies through reductions in fuel consumption. As the product in this case is an air refueling mission, the *Value Stream* consists of all specific actions required to achieve mission success, both on the ground and in the air. In the KC-135, *Flow* starts with mission scheduling and planning, and includes every step in the process until both the aircraft and aircrew are assigned their follow-on mission tasking. The goal in addressing flow is to identify steps in the process that are wasteful. In other words, what steps are aircrews and mission support personnel taking that are not necessary to accomplish the mission? The *Pull* step in the lean tanker process entails the allocation of fuel to assigned or tasked aircraft and aircrew mission planning and execution. The goal is to identify extraneous actions or waste while continuing to meet the mission needs. Implementing a plan to transition fueling from a standard ramp load to *as required* to meet mission requirements would help achieve this goal. Finally, the *Perfection* step in the lean fuel process occurs

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by thoroughly assessing post-mission data to determine if the mission was flown as efficiently as possible and to further identify areas for improvement. This thorough review can identify trends in daily operations, lead to the development of tabulated data that could speed the mission planning process, and eliminate steps deemed nonessential to the success of the mission.

Enhanced fuel efficiency can be achieved without compromising mission effectiveness, and a lean fuel savings initiative would not sacrifice the world class capability of Air Mobility Command's (AMC) tanker fleet. The International Air Transportation Association (IATA) asserts that accurate and efficient fuel management will actually improve safety because it requires additional attention, accuracy, increased situational awareness, and can reduce overall fuel budget by 5 percent.[2] To achieve enhanced mission efficiencies, this article proposes a *leaning* of the current KC-135 mission planning process and the elimination of the currently practiced standard ramp fueling procedures. The goal is to "instill a culture of *energy awareness* in the planning, scheduling, and execution of all AMC activities, from support through training to mission execution."[3]

This article identifies ways to reduce the daily and annual costs of flying AMC KC-135 aircraft by utilizing industry practices to enhance mission fuel efficiencies. These practices are also applicable to Air Education and Training Command (AETC) since their KC-135 missions are analogous to those flown by AMC. The objective is to make this as low cost as possible using current off-the-shelf technology for data analysis (primarily Microsoft Excel) as well as incorporating preexisting infrastructures available at each flying unit in AMC and AETC.

This article demonstrates that the use of lean and just-in-time (JIT) fueling procedures, coupled with the development of a tanker dispatch system, would enable the KC-135 community to accomplish highly efficient mission planning using a fixed targeted shutdown fuel quantity. Therefore, aircraft would be loaded with only the fuel needed to accomplish a given mission, while significantly reducing unnecessary ferrying of fuel. The net result would be a decrease in the amount of fuel required (or purchased) each year.

The following questions are addressed in this article.

Do AMC and AETC KC-135s ferry unneeded gas?

What course or courses of action should AMC and AETC take to improve tanker fuel efficiency?

A review of the applicable literature led to the following research hypothesis: Implementing airline and cargo industry practices of fueling aircraft only as necessary to meet mission requirements will increase KC-135 fuel efficiency.

Article Acronyms

AETC – Air Education and Training Command
AFB – Air Force Base
AFI – Air Force Instruction
AFSAB – Air Force Scientific Advisory Board
AMC – Air Mobility Command
CRE – Corporate Real Estate
DoD – Department of Defense
IATA – International Air Transportation Association
JIT – Just in Time
KIAS – Knots Indicated Airspeed
PMAT – Post-Mission Assessment Tool

Historic Fuel Practices

Traditionally, KC-135 aircraft have been fueled to the maximum load for a worst-case mission scenario which affords maximum flexibility. This practice, generally, is accomplished the night before a planned mission. Air Force Instruction (AFI) 11-2KC-135V3 states, "Units may develop standard ramp loads that meet the minimum local training mission requirements or emergency evacuation requirements (whichever is less)."[4] However, the most common standard ramp load is 80,000 pounds, which far exceeds either of the above requirements. A limitation to an amended fueling practice is the perception that refueling aircraft the night before is essential, because units do not have adequate capability (manpower or equipment) to fuel aircraft just a few hours prior to the flight. The first hurdle is to overcome this mindset and demonstrate how changing the standard refueling sequence of events is in everyone's best interest.

Aviation industry success is very cyclic in nature. Declining profits are quite often a direct result of rising fuel prices. According to one industry estimate, every one cent per gallon increase costs the industry $160M.[5] In the late 1960s, fuel cost 10.4 cents per gallon, and between 1967 and 1972, aviation fuel prices rose at an annual rate of just 2.6 percent.[6] In 1974 the average price per gallon soared 90 percent to 24.2 cents in just 1 year. By 1977 fuel prices averaged 36.2 cents per gallon—a 248 percent increase from 1968. The Organization of Petroleum Exporting Countries fuel crisis of the 1970s caused Department of Defense (DoD) leaders to focus on fuel savings. A RAND Corporation study said that "over the next 50 years fuel reserves [will] continue to be depleted and as supplies diminish, prices will escalate and availability will become less certain both home and abroad."[7] Furthermore, the authors concluded, "to meet the challenge the Air Force [the largest DoD consumer of jet fuel] will be obliged to undertake measures to conserve jet fuel."[8]

From 1978 to 1981, the price of jet fuel increased by over 153 percent. The mid to late 1980s saw a rebound in the economy, and fuel savings initiatives were all but shelved. The Iraqi invasion of Kuwait caused a significant spike in fuel prices, and in October 1990, fuel prices rose from 60 cents a gallon to a peak of $1.40.[9] However, industry losses shrank again in 1994 as a result of lower fuel prices. From the late 1990s to the present, fuel prices have steadily risen. Fuel price increases in 2006 caused the DoD and Air Force leadership to once again become serious about savings across the fleet. In 1996 the DoD price for one gallon of aviation fuel was 77 cents, as shown in Figure 1. By 2006 the cost per gallon had skyrocketed nearly 200 percent with the most dramatic increase occurring from 2005 to 2006, when prices rose from $1.50 to $2.23 per gallon.[10]

There is no indication that the future will see a decrease in fuel prices, so organizations must increase fuel economy. According to IATA, a 1 percent improvement in fuel efficiency across the airline industry can lower fuel costs by $700M.[12] The Department of Transportation has set the goal of improving fuel efficiency per revenue plane mile by 1 percent per year through 2009 which they estimate will save commercial carriers $2B per year.[13]

Fuel Savings Options

The Air Force has identified several methods to save fuel. The Air Force Scientific Advisory Board (AFSAB) indicated the potential for a 5 percent increase in fuel efficiency through "optimization of aircraft operations, engine out taxi, optimum auxiliary power unit usage and optimal route planning." AFSAB identified this as one of its top near-term *operational* solutions.[14] AMC Pamphlet 11-3 states that one way to conserve fuel during the approach and landing phase of flight is to fly short vectors and delay configurations until close to final approach.[15] Early flap and gear extension can cost up to 100 pounds per minute, and fuel flow increases approximately 50 percent when configured. A recent study of KC-135 pattern operations identified the potential savings of completely retracting the flaps during instrument pattern operations. The standard practice is for KC-135s to fly crosswind and downwind portions of the radar pattern with flaps extended to the 20 degree setting. These patterns are currently flown at approximately 180 knots indicated airspeed (KIAS) and can take as long as 15 to 20 minutes per pattern. The study discussed benefits of flying the pattern at speeds of 220 KIAS with the flaps up to decrease pattern time and increase fuel efficiency. Data indicates that this modified pattern flown by KC-135s at Altus Air Force Base (AFB), Oklahoma, could result in a $1M to 1.5M annual fuel savings (2.4 percent) as well as potentially generating up to 18 additional flying hours per month.[16]

Additional significant fuel savings could be attained through the use of reduced engine operations during ground taxi. Several commercial carriers have studied taxiing on one engine whenever possible and in the case of American Airlines, this practice has resulted in a 30 percent fuel reduction and $4M in annual savings.[17] Though the KC-135 is a four engine aircraft, there is no requirement to taxi with all four engines running. However, special considerations must be made for unique KC-135 hydraulic and electric systems requirements, which could be met by starting and taxiing using only the number 3 and number 2 (inboard) engines. Additionally, a training and certification syllabus must be developed for two-engine taxi operations prior to implementation, because as IATA states, "crews who never use engine out taxi procedures will consider them awkward, while crews who consistently use them will consider them routine."[18]

During a site visit to JetBlue Airlines, the manager of JetBlue University technical operations discussed actions the organization has taken to improve fuel savings. Of particular note was the development of a corporate real estate (CRE) unit which addresses various opportunities for savings within the JetBlue organization. According to a CRE memorandum, "With the costs of fuel skyrocketing we knew that if we could carry less fuel but still have a safety margin there would be a savings of $5.2M by not carrying the extra fuel."[19] To further illustrate the value of carrying less fuel, the Dallas Business Journal reported American Airlines had saved $90M per year simply by reducing international and domestic planned ramp arrival fuel.[20]

The AFSAB has identified that enhanced tracking and reporting of Air Force fuel utilization has the potential to achieve fuel savings of up to 3 percent.[21] AMC is the largest consumer of the 2.6 billion gallon Air Force fuel supply, using 1.4 billion gallons per year. Using a $2.50 per gallon assumption, the potential savings equates to approximately $106M per year by changing tracking and reporting procedures alone. The JetBlue CRE provides a model for how the Air Force could address fuel savings. JetBlue has worked to reduce arrival fuels in their Airbus A320 aircraft by reducing the expected fuel on board from 8,500 - 9,500 pounds to 7,500 pounds, a 12 to 21 percent decrease at one location (they have done the same for all their expected arrival locations). In addition, JetBlue is currently developing plans that make corrections for weather conditions and forecasts. Overall, the aggressive initiatives of the CRE have garnered $8.2M savings for JetBlue.[22]

Traditionally, KC-135 initial qualification pilots are trained to mission plan using a *clean-slate* approach, meaning the crews are presented with a specified mission profile and a fixed amount of fuel to accomplish the mission. Mission requirements are generally takeoff, then aerial refueling, followed by two or more hours of proficiency training. Each aircraft is normally fueled with 80,000 pounds, a very common standard fuel load, and crews

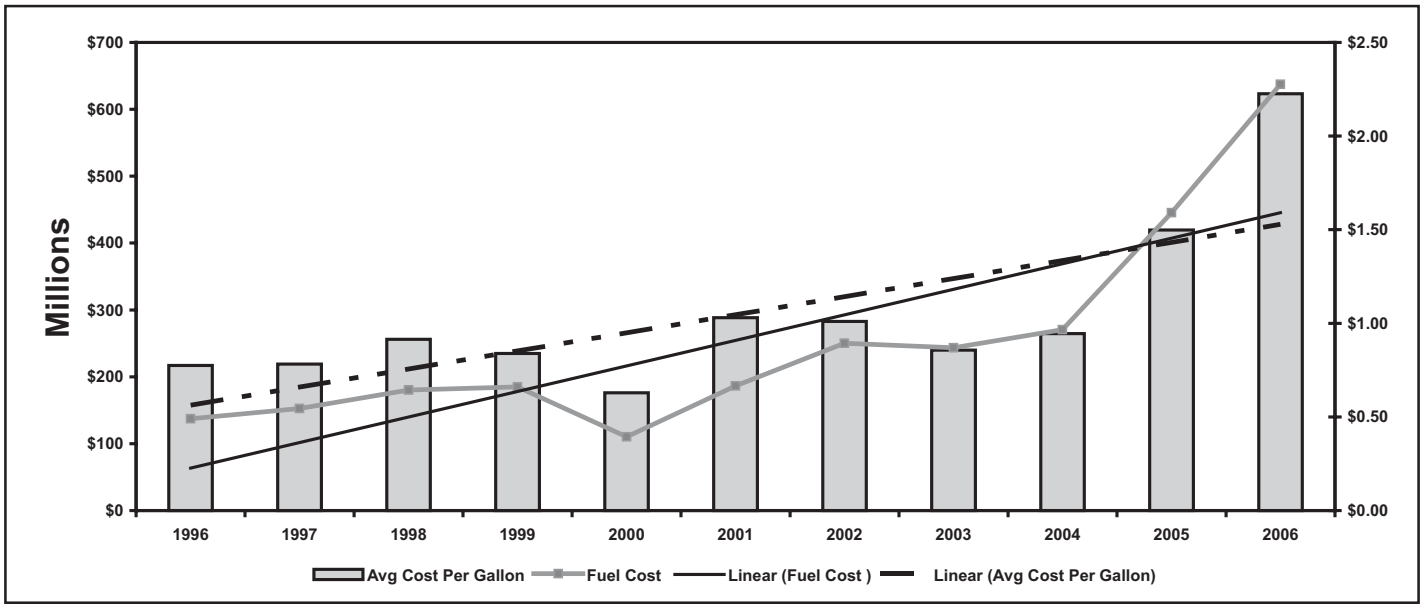

Figure 1. Department of Defense Fuel Prices[11]

are directed to "make the mission happen." A review of nearly 3,500 Altus AFB KC-135 missions over 13 months revealed the average shutdown fuel, given an 80,000 pound standard ramp fuel load, was 33,000 pounds. McConnell AFB local procedures set 15,000 to 25,000 pounds as the mission goal, and Grand Forks AFB local procedures set 25,000 as the normal planned arrival fuel.[23, 24] Assuming a good target shutdown fuel would be 20,000 pounds, the missions flown at Altus AFB land with an average of 13,000 pounds more fuel than is necessary. This seems excessive given that Altus AFB KC-135 aircrews are required to land with a minimum of 15,000 pounds of fuel on board. The commercial aviation industry has recognized the impact of carrying extra fuel. By eliminating extra fuel, American Airlines is cutting an average of 30 minutes flying time, saving 30 million gallons and $50M in annual costs without compromising safety.[25]

The critical key to oversight of mission validation and execution, and ensuring KC-135 crews are operating aircraft in an efficient manner, is an operations and logistics unified dispatch. An important point to make is that this article does not favor a top-down command and control management of the missions from higher headquarters; rather it is advocating what Seddon describes as *local control* found in companies such as Toyota, which places control at the point where the work is done.[26] In the KC-135 case, control would rest with individual dispatch centers, which would remain autonomous and free to schedule missions and make appropriate decisions based on their locations with the mandate that they rigorously pursue the fuel efficiency goals and programs established by AMC headquarters. Using the JetBlue model for decisionmaking, AMC should present the command's fuel efficiency directives, offer units tools (equipment, instructional guidance, and experience) to help them succeed, and then empower them to do so. The following is the JetBlue statement on empowerment: "The decisions you make should be based on our Values—which should be your Values. If they are, your decisions will be fully supported."[27]

Two good Air Force models already in existence for mission dispatch operations can be observed at McGuire AFB, New Jersey, and Fairchild AFB, Washington. Both develop mission activity and plan fuel loads to meet mission requirements in accordance with published directives. Utilizing a central dispatch system, Fairchild AFB KC-135 crews achieved an average shutdown fuel 6,000 pounds below the AMC KC-135 average, based on a review of 462 missions. This was accomplished with the Fairchild AFB Fuel Planning Matrix, which outlines fuel targets to be used during mission planning. For example, mission planners adjust the target shutdown fuel based on current weather forecasts.[28]

To further improve fuel efficiency, central dispatchers should consider reviewing and implementing items listed on the IATA Fuel and Emissions Efficiency Checklist. This checklist enables managers to audit their current fuel practices to ensure they are taking advantage of all available avenues to reduce fuel.[29] A review of the IATA checklist yielded the sample of questions included in Table 1, which could pertain to KC-135 dispatch operations. This list is not all encompassing; rather it is meant to illustrate the usefulness of the IATA checklist to AMC. The complete IATA checklist can be found at http://www.iata.org.

Data Sources

AFI 11-2KC-135V3 states that every pound of excess fuel carried results in an increased fuel burn rate of 3 percent per hour in the KC-135.[30] This is the premise behind the Microsoft Excel-based Post-Mission Assessment Tool (PMAT) developed for this research project. PMAT determines excess fuel used on KC-135 missions (if any), calculates the fuel penalty for *ferrying* the fuel, and determines potential cost savings of targeted shutdown fuel levels.

In order to determine current levels of fuel consumption in the KC-135 fleet, calendar year 2006 post-mission summaries from AETC and AMC tanker units were compiled and evaluated using the PMAT. Some KC-10 data was also included for comparison. AMC summaries were provided by AMC Standardization and Evaluations, and AETC data were provided by Altus AFB, Oklahoma.

PMAT input data consisted of actual and planned (scheduled) KC-135 start fuel, fuel offloaded (total fuel delivered via in-flight refueling), shutdown fuel, and mission duration as shown in Table 2.

To better represent actual performance, missions that returned to home station with excess fuel due to maintenance issues or in-flight emergencies, in-flight refueling receiver cancellations, or special training requiring a higher shutdown fuel were removed from consideration.

Post-Mission Assessment

Based on post-mission summary data, the PMAT determines which missions were flown with excessive fuel for mission requirements (assuming a targeted shutdown fuel of 15,000, 20,000, or 25,000 pounds), derives a dollar cost of ferrying the excess fuel at $2.50 per gallon, and calculates the number of fully loaded KC-135s the excess fuel represents. The model assumes 10,718 pounds per hour fuel burn rate which was obtained from Air Force Pamphlet 10-1403, *Air Mobility Planning Factors*.[31] The PMAT offers a tool for planners to make rapid fuel load calculations that can be used as a starting point for mission

	Checklist Item	Response
1.1	Is your airline schedule built for maximum efficiency?	Yes/No (comments)
2.5	Are your dispatchers adding fuel for ad hoc reasons?	Yes/No (comments)
2.6	Do you have a well-defined and clear fuel plan?	Yes/No (comments)
2.7	Do you have a recommended arrival fuel for each airport over which dispatchers and pilots should look for opportunities?	Yes/No (comments)
3.1	Are all of your pilots up to the same standard regarding fuel efficient flying? Do you train pilots and dispatchers on the policy?	Yes/No (comments)
3.2	Are crews trained on efficient FMS programming to cross check flight plan fuel and accuracy to manage the fuel in-flight?	Yes/No (comments)

Table 1. Sample IATA Fuel and Emission Efficiency Checklist

planning as well as identifies potential man-hour savings for logistics and aircraft maintenance personnel.

Results

A review of 702 McConnell AFB, Kansas, missions from May to October 2006 revealed the average planned shutdown fuel was 31,000 pounds, but the average actual shutdown fuel was 36,700 pounds. This was 18 percent greater than the mission planned shutdown and 45 to 110 percent more than the local requirement. Table 3 illustrates an estimate of the potential annual savings for McConnell AFB by transitioning to a targeted shutdown fuel.

Incorporating 1,461 AMC KC-135 missions from five operating bases yielded the estimated potential savings for AMC depicted in Table 4.

Based on this KC-135 research, the implications of transitioning from a standard ramp load to a targeted shutdown fuel for the Air Force are quite significant. Results indicated the penalty for ferrying excess fuel ranged from 10.2 to 14.8 million pounds. As such, KC-135s are burning approximately 1 percent of AMC's total annual fuel to do nothing more than carry extra gas. After consolidating AMC results with AETC data, PMAT estimated the potential Air Force KC-135 fuel savings shown in Table 5.

In addition to fuel cost savings, manpower represents another area of potential savings identified by this research. Ground refueling of a KC-135 requires one fuels specialist and two to three aircraft maintenance personnel. The fueling process takes approximately 1 hour for every 27,000 pounds of fuel loaded. If aircraft were only loaded to meet mission requirements, the workload of KC-135 maintenance and logistics personnel could be significantly reduced. To better illustrate this point, 16 to 20 million pounds would not have been loaded onto aircraft had the AETC missions in this study been planned using a targeted shutdown fuel. This equates to a savings of 1,800 to 2,200 man hours. Since the average AMC shutdown fuel is greater than the AETC mission average, potential man hour savings are significantly higher for AMC. The manpower benefits from a targeted shutdown fuel plan are a step in the right direction towards addressing the effects of pending personnel cuts.

Optimized Mission Planning

Based partially on the results of this article, AMC directed the immediate elimination of the standard ramp fuel practice. In order to comply with this guidance, KC-135 units should transition to an airline industry model of using dispatched mission planning, and loading only the fuel required for mission accomplishment. This should reduce the amount of fuel carried and eliminate excess consumption associated with ferrying unneeded fuel. The proposed model incorporates multiple aspects of the KC-135 mission planning and execution process including mission support, dispatch planning, and post-mission analysis.

Squadron	Month-Year							
Name	Fuel at Engine Start		Air Refuel Onload/Offload		Shutdown Fuel		Mission Duration	
Date or Call Sign	Actual	Scheduled	Actual	Scheduled	Actual	Scheduled	Actual	Scheduled
Day-Month-Year	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2. PMAT Data Entry Sheet

Estimate for 1 Year	Pounds	Gallons	Cost	KC-135s*
15K Shutdown	5,231,489.86	780,819.38	$1,952,048.45	26.16
20K Shutdown	4,434,820.22	661,913.47	$1,654,783.66	22.17
25K Shutdown	3,612,322.98	539,152.68	$1,347,881.71	18.06
*Indicates number of fully loaded KC-135s				

Table 3. McConnell Fuel Savings

Estimate for 1 Year	Pounds	Gallons	Cost	200K/lbs*
15K Shutdown	14,891,383.03	2,222,594.48	$5.556,486.20	74.46
20K Shutdown	12,567,795.17	1,875,790.32	$4,689,475.81	62.84
25K Shutdown	10,223,812.12	1,525,942.11	$3,814,855.27	51.12
*Indicates the number of fully-loaded KC-135s (200K lbs) the savings equal				

Table 4. AMC Potential Savings

Estimate for 1 Year	Pounds	Gallons	Cost	200K/lbs
15K Shutdown	22,537,299.29	3,363,776.01	$8,409,440.03	112.69
20K Shutdown	18,118,782.35	2,704,295.87	$6,760,739.68	90.59
25K Shutdown	13,586,691.53	2,027,864.41	$5,069,661.02	67.93
Reflects the consolidation of AETC and AMC estimated fuel savings—does not include ANG/AFRES aircraft				

Table 5. Air Force Potential Savings

Ground Support Functions

Using an industry model, fuel would not be loaded onto the aircraft until the last possible moment. At a specified time (for example, 6 hours prior to aircrew show time), maintenance personnel would begin to accomplish all required preflight activities. This aircraft generation process requires one fuel personnel and a crew of two to three maintenance personnel, as well as a fuel truck to pump fuel. When the required mission fuel quantity has been finalized by the dispatch center, fuel then begins loading onto the aircraft. The fuel *finalization* process is the key component of a successful mission fuel reduction effort. Several hours prior to a mission, the dispatch center would calculate the *planned fuel* and establish a target fuel load for the maintenance personnel to use for planning. Subsequently, the assigned aircraft commander would verify that the proposed mission fuel is adequate to meet requirements after a careful assessment of the flight plan, prevailing and forecasted weather, and any unique receiver aircraft requirements. Then the final just-in-time fuel is loaded onto the aircraft.

Service management tools such as Gantt project charts could be useful when considering the generation of aircraft as a project and mapping out the fueling process from the time the aircraft lands to the scheduled departure time of the aircraft's subsequent mission. Network diagrams and facility layouts could also be used for flight line prepositioning of required aircraft generation and fueling equipment. Gantt charts could be helpful in determining the necessary timing of individual aircraft pre- and post-flight actions to include mission development, fuel allocation, and action points necessary for the fueling of aircraft based on a scheduled departure time.[32]

Quite often fuel trucks and fueling crews move from aircraft to aircraft in order of departure priority which is not necessarily based on aircraft parking location. Network diagrams could be developed to identify the shortest routes for fuel trucks to travel from transportation storage locations to their assigned aircraft parking locations. These distances can range from as short as several hundred yards to a few miles depending on where aircraft are parked following a mission. Network diagrams could also be used to identify optimum locations for prepositioning aircraft generation and fueling equipment to help further expedite the process. By mapping key paths using Clarke-Wright Algorithms, the shortest distances could be determined daily.[33] This could be useful in several ways, such as mapping out optimum route paths to support aircraft already assigned to particular parking locations or by determining the optimal parking location for an arriving aircraft in more advanced planning.

Potential benefits that could be achieved are increases in both manpower and equipment efficiency through decreases in the time required to accomplish dispatched fueling system tasks. Following a successful demonstration, the KC-135 dispatch system could become the aircraft generation model to be used by all AMC units. Accurate mapping of aircraft generation processes could result in not only a decrease in aircraft fuel consumption but also a reduction in man hours as well as ground support equipment and vehicle fuel usage. Using these service management tools could provide the added benefit of enabling an efficiency assessment of individual processes. This would allow managers to quantify the amount of time required to accomplish aircraft generation, what percentage of time workers actually contribute value to the service, and how much system capacity is utilized. This application of lean principles would help determine what events could be combined or possibly eliminated.

Dispatch Operations

Under a central dispatch system, aircraft would be fueled to the proposed fuel load beginning 2 hours prior to aircrew show time (unless more time is needed to accommodate larger fuel loads). Aircrews would arrive approximately 4 hours prior to takeoff, review the mission plan, and confirm the target fuel load is appropriate to meet mission needs. At 3 hours prior to takeoff, any final adjustments to fuel load must be made to allow for JIT fueling.

Following the mission, all crews would file post-mission summaries with central dispatchers. With the aircraft commander present, a central dispatch representative would load mission summary information into the PMAT to assess mission efficiency, note any mission deviations, gather feedback on the mission plan, and determine necessary changes to fuel loads for subsequent missions.

While $28M is a significant amount of money, initial indications show the possibility of savings in excess of $160M per year through the application of major fuel efficiency initiatives across the command.

Aircrew Training

The next step in improving fuel efficiency is the development of an aircrew training syllabus that would encompass the new mission planning procedures. Crews should be trained during initial qualification to accomplish mission planning using the central dispatch mission process and targeted fuel loads. A scenario-based KC-135 mission planner course should also be developed to create *energy awareness*. This course should expose aircrews to mission tasking, planning, and fuel allocation. Following a simulation of the plan, aircrews should conduct a review of the mission using PMAT to determine if the mission could have been planned or flown in a more efficient manner.

Development of AMC Energy Division

AMC should consider the development of an energy division consisting of operations and logistics personnel whose primary tasks consist of monitoring fuel consumption rates and continuously exploring industry fuel savings practices. This office would develop a briefing consisting of industry best practices and then travel to each AMC unit to discuss issues with aircrews and logistics personnel in a combined forum. A portion

of their briefing should provide the command's perspective on AMC Pamphlet 11-3. When they travel to each base, they would review and observe the dispatch process as well as survey aircrews to determine how well energy initiatives are being applied. This approach complements the lean principle of the continual pursuit of *Perfection*.

Culture Change

The prevailing theme of site visits to several commercial air carriers is that successful fuel savings is a cultural issue. Fostering cultural change is not easy; however, there are some lessons that can be learned. At United, increasing fuel efficiency was taken so seriously by the company that they placed one of their most senior and experienced pilots in charge of the effort as Manager of Operational Efficiency. This gave significant credibility to the effort. They also focused on training their pilots and dispatchers together which helped them to develop and maintain efficiency gains.

Conclusion

The focus of this research was on increasing KC-135 fuel efficiency through mission planning enhanced by lean principles. By implementing targeted fuel loads and a central dispatch system, significant fuel savings are possible. The concepts and findings addressed could be tailored to various AMC aircraft mission processes. AMC is the largest consumer of fuel in the DoD, and flew over 142,000 sorties in 2005. "If $200 were saved on every sortie, then the command could save over $28M per year. While $28M is a significant amount of money, initial indications show the possibility of savings in excess of $160M per year through the application of major fuel efficiency initiatives across the command."[34]

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If I had to sum up in a word what makes a good manager, I'd say decisiveness. You can use the fanciest computers to gather the numbers, but in the end you have to set a timetable and act.

—Lido Anthony (Lee) Iacocca

If opportunity doesn't knock, build a door.

—Milton Berle