KC-135 FORCE STRUCTURE: IDENTIFYING OPERATIONAL AND FISCAL INEFFICIENCIES

GRADUATE RESEARCH PAPER

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AFIT-ENS-MS-19-J-044

DEPARTMENT OF THE AIR FORCE
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Wright-Patterson Air Force Base, Ohio

AFIT-ENS-MS-19-J-044

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GRADUATE RESEARCH PAPER

Presented to the Faculty

Department of Operational Sciences

Graduate School of Engineering and Management

Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Operations Management

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June, 2019

AFIT-ENS-MS-19-J-044

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AFIT-ENS-MS-17-J-044

Abstract

The KC-135 Stratotanker is one of the most numerous and widespread aircraft in the Air Force's fleet. With 396 aircraft located at 31 different installations, a massive amount of infrastructure is dedicated to supporting the airframe. This research proposes that there are too many operating locations in the KC-135 force structure, which is a result of the numerous small unit sizes operating in the Air Force Reserve and Air National Guard components. The researcher hypothesizes that the current state of the KC-135 force structure is having a negative impact on the airframe's operational readiness rates while also imposing excess infrastructure costs on the Air Force due to inefficient unit sizes. The researcher uses a qualitative analysis to detail the history of the KC-135 force structure and to describe how the current force structure impacts daily operations. Following this, the researcher demonstrates that larger KC-135 units have statistically higher aircraft availability rates than smaller units. Finally, the researcher uses quantitative analysis to show that larger KC-135 units are more economically efficient than smaller units.

This research paper recommends the consolidation of existing KC-135 units in the Air Reserve Component. This would increase unit fleet sizes, improve aircraft availability rates, and save money on infrastructure and overhead costs. The researcher recognizes that closing units for consolidation is a politically sensitive issue, and does not recommend any specific units for closure. Instead, the researcher recommends that Congress convene a future Base Realignment and Closure round and use the findings from this research to construct a more efficient force structure for the KC-135.

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KC-135 FORCE STRUCTURE: IDENTIFYING OPERATIONAL AND FISCAL INEFFICIENCIES

I. Introduction

On April 14, 2016, the Deputy Secretary of Defense sent an interim report to congressional defense committees indicating that the Department of Defense (DoD) had an excess infrastructure capacity of 22 percent compared to Fiscal Year (FY) 2019 force levels (DoD, 2017). In October 2017, the DoD Infrastructure Capacity report was published, and the Air Force was highlighted as having as much as 32 percent excess inventory – the second highest in the Department (DoD, 2017). One of the recommendations from this report was for Congress to authorize another round of Base Realignment and Closure (BRAC) in FY21 in order to begin divesting the DoD of its excess infrastructure (DoD, 2017).

Within the United States Air Force (USAF), one of the largest aircraft fleets is the Boeing KC-135 Stratotanker, with 396 aircraft spread across 31 installations belonging to the Active Duty (AD), Air Force Reserve Command (AFRC), and Air National Guard (ANG) components (Air Mobility Command, 2018). Within those 31 installations, there are 34 wings associated with the KC-135, with the majority of these wings being "single mission" wings – meaning that the KC-135 is the only airframe within the assigned mission set of those wings. No other airframe has as many permanent operational locations across the USAF as the KC-135 does. The next closest airframe is the C-130H/J, which operates at 29 installations around the globe (Air Mobility Command, 2018). Given the USAF's high level of excess infrastructure, it is likely that much of it may very well lie within the KC-135 community with its wide proliferation across the total force.

Background

First fielded in 1956, the KC-135 Stratotanker has served as the core air refueling capability of the USAF for more than 60 years. ("KC-135 Fact Sheet," 2018). This airframe directly contributes to the USAF's core mission of Rapid Global Mobility (RGM), which is the ability to project power quickly to anywhere on the planet (Welsh, 2013). It does so primarily through air refueling, not only to USAF aircraft, but also to Navy, Marine Corps, and allied nation aircraft as well. By enabling joint power projection over intercontinental distances through the capability of air refueling, the KC-135s impact on strategic operations is evident. Deploying fighter units across the ocean or enabling critical command and control assets to stay airborne for long duration sorties would not be possible without air refueling. Given that 87 percent of the USAF's current tanker fleet is composed of KC-135s, this airframe is providing the majority of air refueling capabilities for not only the USAF, but also the nation.

The KC-135 Stratotanker was originally designed to provide air refueling support to strategic bombers such as the B-52 to allow them to reach their targets in the event of nuclear war (Hopkins III, 1997). In fact, for the first three decades of its service, the Stratotanker existed almost entirely within Strategic Air Command (SAC) for the sole purpose of strategic bomber support (Shelton, 2016). While its mission set has broadened since then, the KC-135 remains the only currently-fielded tanker aircraft that is equipped to carry out this mission set during nuclear warfare scenarios, as governed by US Strategic

Command Operations Plans (OPLANs) (AFI 11-2KC-135, 2018). Additionally, the KC-135 is considered a national High Value Airborne Asset (HVAA), as evidenced by a HVAA study recently convened by Air Mobility Command (AMC) that focused partly on critical survivability upgrades for the Stratotanker (Insinna, 2018). Accordingly, it is clear that the KC-135 is considered a national strategic asset that is vital to the defense of the United States.

The KC-135 is unique among strategic assets in that it is both numerous and widely deployed. However, of the 396 aircraft in the fleet, more than 61 percent of them (243 aircraft) are in the Air Reserve Component (ARC). When factoring out Outside Contiguous United States (OCONUS) and Air Education and Training Command (AETC) bases that possess KC-135s and are not tied to AMC, that rate jumps to 69 percent. Within the total fleet, 18.8 percent (72 aircraft) of KC-135s are owned by AFRC, with the remaining 43.2 percent (171 aircraft) being owned by the ANG. Of the 153 KC-135s owned by the Active Component, only 105 of them fall within AMC units (AMC, 2018). No other HVAA has such a significant percentage of operational assets assigned to the ARC.

As with most scenarios, there are both pros and cons to this force allocation. Having a large portion of the KC-135 fleet in the ARC creates a large pool of aircraft and personnel that can be mobilized during contingencies to offset the air refueling workload that would be expected of the AD units. Additionally, AFRC and ANG tanker units have been on steady deployment rotations to CENTCOM for years, alleviating the burden on the Active Component. However, the nature of Title 10 (Active Duty/Reserve) status versus Title 32 (National Guard) status means that KC-135s attached to the ANG are under the control and direction of the owning state unless mobilized for AD ("Difference Between Guard and

Reserve," 2016). This changes the nature for how these tankers can be used during day-to-day operations. Before a KC-135 in the ARC can be tasked by AMC for a United States Transportation Command (USTRANSCOM) mission during non-contingency operations, the respective AFRC and ANG units must agree to volunteer to fill the mission (618 AOC, 2019). Additionally, full mobilization of the ARC requires time, especially compared to the Active Component, as most Reserve and Guard personnel are not on full-time status. This fact, coupled with an August 2018 RAND report that shows that no category of USAF aircraft had enough availability to meet required demand during four potential contingency scenarios, raises concerns about the availability of this national strategic asset (Vick et al., 2018). How and why did so many KC-135s end up within the ARC?

Over the past few decades, the Mobility Air Forces (MAF) have witnessed the proliferation of mobility units across the Total Force, with the vast majority of units residing within the ARC. Among those units found in AFRC or the ANG, most own only a small number of aircraft compared to the major operating bases found in the Active Component of MAF (AMC, 2018). There are several factors that have contributed to this reality. Foremost among them is Congress, which has often dictated to the USAF when and where aircraft will be assigned, despite objections from the Service. A trend has institutionalized itself within Congress where congressional members from various states convince party leadership and ranking committee members to support their efforts to secure the future of the ANG and AFRC units in their home districts. This is often conducted with little concern for military necessity, and contravenes desires of the USAF.

Yet, some of the current force structure issues are also partly self-inflicted. The combined effects of Sequestration and the Budget Control Act drove the RGM Core

Function, led by AMC, to get within its Total Obligation Authority by offsetting force structure. This was done primarily through the conversion of possessed aircraft to Backup Aircraft Inventory (BAI) status, and by moving aircraft and personnel to AFRC and ANG, where the annual Military Personnel (MILPERS) and Operations & Maintenance (O&M) bills would be smaller (AMC A5/8, 2018).

As a result, there now exists an apparent surplus of small-sized MAF units across the Guard and Reserve. In fact, of the 67 installations with MAF mission sets that are based within the Contiguous United States (CONUS), only 12 of them are installations where MAF is both the primary mission set and the lead unit is an AD wing. Establishing wings around small fleets, many of which are composed of only eight assigned aircraft, creates inefficiencies due to the overhead incumbent in wing-level organizations along with the infrastructure required to support a wing-level organization. Furthermore, these inefficiencies impose a recurring fixed cost upon the overall MAF portfolio, diverting funding from programs such as modernization initiatives. Finally, with the ARC possessing an increasingly larger share of mobility aircraft, particularly the KC-135 Stratotanker, fewer aircraft within these fleets become available for tasking on a daily basis by the 618th Air Operations Center (618 AOC) at Scott Air Force Base (AFB), IL.

Problem Statement

There is an inefficient mix of Active Duty, Guard, and Reserve basing across the KC-135 fleet, which leads to increased infrastructure and manpower costs while limiting the number of aircraft available for tasking. The purpose of this research is to conduct an analysis of the current KC-135 force structure in order to explain how the USAF arrived at this current force structure, and then to identify both operational and fiscal inefficiencies that exist in the current basing construct.

Research Questions

This paper seeks to answer three primary questions by addressing two investigative questions:

RESEARCH QUESTION 1: How did the USAF arrive at the current KC-135 force structure?

RESEARCH QUESTION 2: How does the current KC-135 force structure impact the USAF operationally?

INVESTIGATIVE QUESTION 2a: How does the current KC-135 force structure impact AFRC and ANG aircraft availability (AA) rates?

INVESTIGATIVE QUESTION 2b: How does the current KC-135 force structure impact daily operations for the 618th Air Operations Center?

RESEARCH QUESTION 3: How does the current KC-135 force structure impact the USAF fiscally?

Assumptions

Several assumptions are necessary to make recommendations for the future tanker force structure.

Assumption # 1.

KC-135 wings of similar size (i.e. same numbers of Primary Aerospace Vehicles Authorized) and within the same total force component will have annual operating costs that are comparable. This is a reasonable assumption since similarly-sized wings have the same mission set and support agencies required to support the mission.

Assumption # 2.

Returning KC-135s from the ARC to the Active Component is not a tenable solution due to the limited number of current AD KC-135 bases. Kadena and Mildenhall Air Bases belong to the Pacific Air Forces and United States Air Forces in Europe – Air Force Africa, respectively. As such, they are not taskable by the 618 AOC, and are thus outside the scope of this paper's problem statement. Altus AFB is a training base under AETC, and is similarly not taskable by the 618 AOC. MacDill AFB recently expanded from 16 to 24 KC-135 aircraft (HQ AMC, 2018) and is likely at or near maximum capacity due to limited real estate at that base, which is also home to two Combatant Commands (Congressional Research Service, 2013). McConnell AFB is currently in the process of converting from KC-135s to KC-46s, and Fairchild AFB will receive most of the aircraft from McConnell (Liapis, 2017). Finally, Travis AFB and Joint Base (JB) McGuire-Dix-Lakehurst are currently home to the entire KC-10 Extender fleet. With the pending retirement of that fleet within the next five years, these bases have also been announced as future homes for the KC-46 Pegasus (Levinski, 2018) and thus are not good candidates for standing up KC-135 units.

Assumption #3.

Recommending specific Air National Guard and Air Force Reserve KC-135 units for consolidation would not benefit the purpose of this research. When specific units are named, politics come into play, which will result in stiff resistance from congressional members affected by the proposed moves. The USAF lacks the authority to unilaterally close bases. Instead, the only realistic option for base closure and consolidation would be a new round of BRAC (Hebert, 2016). When building a scenario for base consolidation, this paper will only recommend a certain number of bases for consolidation for the purpose of demonstrating what the potential savings would be if consolidation were to occur in a future BRAC.

Assumption #4.

Congress convening another BRAC round within the next few years is a possibility.

Assumption #5.

SecAF Heather Wilson's announcement during the 2018 Air Force Association Air, Space, and Cyber Conference that the USAF will expand from 312 operational squadrons to 386 operational squadrons by 2030, to include 14 additional tanker squadrons ("The Air Force We Need," 2018), will not be fully realized within the timeframe. The 14 additional tanker squadrons would have to be composed of either KC-46 aircraft (which is currently programmed to 179 aircraft) or KC-135s pulled out of retirement, or by retaining KC-135s that are currently slated for retirement as the KC-46 is delivered. With initial delivery of the KC-46 having been delayed more than a year beyond initial agreements between the USAF and Boeing, the current 179 aircraft on order will likely not be delivered until around the 2030 timeframe (Masunaga, 2018). Furthermore, pulling Stratotankers out of retirement is not an optimal solution, as those aircraft will have to be rebuilt with parts that are no longer readily available, and will face numerous maintainability issues once restored. However, by retaining those 96 KC-135s that are planned for retirement over the next ten years, the USAF could potentially expand the number of tanker squadrons beyond the current number. There is also the massive hurdle of obtaining the funding required to grow the Air Foce by 74 squadrons, which in today's fiscally uncertain environment is no guarantee. An estimate published by the Brookings Institution shortly after the announcement claims that the USAF's budget would have to grow by 15 percent, or $25 billion, to realize the SecAF's vision (O'Hanlon, 2018). Finally, SecAF Wilson announced her retirement in March of 2019, with her departure set for 31 May 2019 (Losey, 2019). With this reality, it is likely that the momentum for expanding the USAF to 386 squadrons will lose traction in the near future.

Limitations

This research project is limited to unclassified information. Recommendations do not consider applicable OPLAN support beyond the basic level to keep the research material at the unclassified level. Obtaining full access to affected OPLANs may prove extremely difficult given the classification levels involved. Additionally, this research does not analyze the operational imperatives that may have driven past KC-135 basing decisions.

Scope

The scope of this paper will encompass the entire AMC, AFRC, and ANG KC-135 force structure. A quantitative analysis will be conducted to statistically compare AA rates between the various unit sizes within the ARC to determine if larger units have better readiness rates than units with eight Total Aircraft Inventory (TAI), which is typically the smallest unit size. Additionally, analysis will be conducted in order to compare the annual operating costs of wings of different Primary Aerospace Vehicles Authorized (PAA) sizes within the ARC to identify potential savings through consolidation. In this paper, consolidation refers to the act of "standing down" one or more units and reassigning their KC-135s to an existing tanker unit, thus the recipient will have a larger PAA fleet size than before. This will not be a line-by-line breakdown of what each individual aspect of a wing costs, nor will it mention specific units by name. Recommended courses of action will focus on a targeted number of wings for consolidation within the current force structure.

II. Literature Review

There is a paucity of reports on the issue of the KC-135 force structure likely due to the specificity of the subject. Yet, there are several recent reports that pertain to DoD infrastructure and the overall force structure of the USAF that have relevance to the research problem. Additionally, AMC published a Lead Command Intent report on the KC-46, which includes many proposed criteria for basing decisions. Finally, USTRANSCOM recently published the 2018 Mobility Capabilities and Requirements Study (MCRS), which has major implications for the entire air mobility community. These reports are summarized below.

2017 DoD Infrastructure Capacity Report

As mentioned in the introduction of this paper, the DoD recently published its 2017 Infrastructure Capacity report. The report has two components: a force structure plan for each Military Service informed by the Secretary's assessment of probable threats to national security, and a world-wide inventory of installations for both the active and reserve forces (DoD, 2017). Given that this report is looking at infrastructure from the Department level, the KC-135 force structure is not specifically addressed in the report. However, there are major implications for the USAF within the report. The report concluded that the USAF has 32 percent excess inventory for FY19, the second highest among the services (DoD, 2017). Within the USAF, the report looked at aircraft inventory, manpower levels, and the type and number of installations. With respect to this research, the two categories of installations that had noteworthy excess infrastructure compared to FY12 were AFRC units at 19 percent excess capacity and Large Aircraft units (e.g. KC-135 squadrons), which were at 30 percent excess (DoD, 2017).

The methodology used to obtain this figure was somewhat inscrutable, as it did not sufficiently explain what metrics were used and what baselines the metrics were compared to, and the algorithm used for determining excess infrastructure was complicated. Despite this, the results of the report, assuming a proper methodology was used, are clearly stated in terms of the amount of excess infrastructure. The key recommendation made by the study was to re-emphasize the DoD's desire for a new round of BRAC to be authorized by Congress in order to address the problem of excess infrastructure. The report noted that it has been 14 years since the last BRAC was authorized, and that the next round should focus on saving money and maximizing efficiency, in lieu of being a "transformational" BRAC much like the 2005 iteration that brought significant changes to the DoD construct (DoD, 2017). One of the purposes of this research is to find ways to save money and increase efficiency within the current KC-135 force structure, which aligns with the DoD's goals for a new BRAC. Furthermore, the only realistic chance for the changes that ought to be made with the KC-135 force structure to occur are through another round of BRAC.

2014 National Commission on the Structure of the Air Force

In 2014, a group of officials, including a former AMC Commander, who were formed under the "National Commission on the Structure of the Air Force," testified before the Senate Armed Services Committee (SASC) on their findings (McCarthy et al., 2014). The purpose of this commission was to ensure that the United States retained the strongest and most effective Air Force possible given current security concerns and budgetary constraints. Specifically, it considered the issues of Combatant Commander requirements, balancing the Active and Reserve Components, and force structure requirements given current operations tempos, among other things (McCarthy et al., 2014). From this, the commission determined that their ultimate goal was to optimize the Total Force construct, while preserving capacity and maintaining a strong Air Force. The commission praised the USAF for the high level of integration is currently experiences between the AD and Reserve components and how both components are held to the same standard of operational readiness. In fact, the commission recommended that the USAF speed up the pace of integration between the components to enhance cross-component operational capabilities.

Tying into this idea of Total Force integration, the commission strongly advocated for the introduction of the "I-Wing" (Integrated Wing) concept that is now being tested by the USAF. There are several different models for a potential I-Wing, but all of them are structured around the idea of functionally integrating similar organizations at a particular base to streamline chains of command and better meet mission requirements ("Air Force Announces Standup," 2016). This means integrating Active, Reserve, and Guard wings that are based at the same installation, which is certainly a radical concept compared to the current model. There is currently one base testing the I-Wing concept – Seymour Johnson AFB in North Carolina. Only the MAF units at this base are participating, with the Active Duty 911th Air Refueling Squadron (ARS) integrating with the 916th Air Refueling Wing (ARW), which is a Reserve unit ("Air Force Announces Standup," 2016). Previously, the 911 ARS was an Active Associate unit to the 916 ARW, where the two units shared the same KC-135 Stratotankers but had separate administrative chains of command, with the 911 ARS falling under the 6th Air Mobility Wing (AMW) at MacDill AFB, Florida – an

AD AMC unit. With the testing of the I-Wing concept, these two units are now effectively operating as one, sharing the same Designed Operational Capability document that dictates their mission requirements. The strengths and weakness of the I-Wing concept are still being evaluated, but if it is to be adopted at additional bases in the future, it could have implications for the KC-135 force structure. Additionally, as the commission noted, I-Wings could potentially reduce administrative overhead and allow for a smaller infrastructure footprint, which is a looming challenge facing the USAF.

The commission provided additional recommendations to address the rising costs infrastructure is levying against the USAF. One request was for Congress to grant the USAF flexibility when it comes to closing or "warm basing" units – that is, to staff them with the minimum number of personnel required for the mission (McCarthy et al., 2014). Despite the weight behind this recommendation, Congress has shown an affinity for having a say in every basing decision made by the military, and is unlikely to relinquish such control to one of the Services.

The commission's most drastic recommendations came on the topic of force mix and the future of the Air Force Reserves. While not listed as a recommendation, the commission did provide a goalpost for what a healthy and balance force mix (with regards to manpower) within the USAF would look like. They determined that a 58 percent Active/42 percent ARC split is ideal, or at least close to what the USAF should strive to attain in the future. This would require the transfer of 36,000 manpower positions from the Active Component to the ARC, for the purpose of relying more heavily on the ARC for steady-state and non-contingency missions (McCarthy et al., 2014). While those figures are in terms of manpower, it is interesting to contrast that ratio of personnel to the ratio of KC-

135s in the two components, which comes to 38.6 percent Active versus 61.4 ARC. This is a reversal of that ratio, and even though the commission recommends boosting reliance on the ARC (through increased integration), it is implied in that recommendation that ARC forces would more often than not be aligned under AD units. This is evidenced in a bold prediction from the commission - as units become more integrated, both through the I-Wing concept and Major Command (MAJCOM) staff integration, the requirement for a separate AFRC will disappear (McCarthy et al., 2014). In such a scenario, all the staffing positions within AFRC would be integrated into their respective AD Numbered Air Forces (NAFs) and MAJCOMs and their subordinate wings, thus increasing representation by ARC Airmen across the Active Component. This would result in the Active Component owning a significantly higher portion of USAF aircraft compared to the current state, but with a greater proportion of ARC Airmen.

KC-46 Lead Command Intent

In 2012, AMC, as the lead command for the KC-46 Pegasus, published a “KC-46 Lead Command Intent” paper, outlining AMC’s intent for basing and employing the 179 KC-46s that the USAF intends to purchase. The stated goal of developing a KC-46 strategic basing concept is to “provide optimum Combatant Commander (CCDR) support and to efficiently meet regional and global receiver demands while recapitalizing the KC-135 fleet. Basing decisions will leverage existing infrastructure to ensure fiscally responsible and effective support across the mobility spectrum,” (AMC, 2012). Strategic basing considerations for the KC-46 fall in to two categories. First, whether or not the Pegasus can physically be supported at a particular base. Second, whether or not the Pegasus *should* be based at a particular location based on mission and geographic requirements. With these criteria, AMC created a basing roadmap for the KC-46 consisting of ten Main Operating Bases (MOBs) and one Formal Training Unit (FTU) at Altus AFB, although to date only three MOBs have been identified.

Of the 179 KC-46s to be purchased by the USAF, 160 will be coded as Combat Support aircraft, which is the same as PAA. Six to eight aircraft will be coded as training aircraft to be stationed at Altus AFB, and the remaining 11 to 13 aircraft will be coded as BAI, stationed alongside the 160 PAA aircraft at the MOBs (AMC, 2012). When determining the basing construct for these 179 aircraft, the USAF strongly considered the Total Force Integration (TFI) initiative of 2004 and DoD Directive 1200.17 "Managing the Reserve Components as an Operational Force," by factoring unit associations into the plan. Associations are designed to help bases achieve a desired AD/ARC mix, increasing flexibility compared to units without associations.

Unit associations occur when the owner of a fleet of aircraft at a particular installation share those aircraft with an "associate" unit which also operates the same aircraft but does not have any ownership of those aircraft. There are several types of associations, but the two most common ones are the Classic Association and the Active Association, which are also the only ones factored into the KC-46 basing plan. The Classic Association occurs when an AD Air Force unit retains principal responsibility for a weapon system or systems and shares the equipment with one or more reserve component units. Under the classic associate structure, active-duty and reserve units retain separate organizational structures and chains of command. In contrast is the Active Association, where an ARC unit has principal responsibility for a weapon system or systems and shares the equipment with one or more AD Air Force units, while also retaining separate organizational structures (Air Force Reserve Command, 2013).

In order to facilitate TFI, in 2012 then-SecAF Michael Donley directed that all CONUS KC-46 bases will have associations (AMC, 2012). Speaking to this decision, Secretary Donley noted that "The Air National Guard and Air Force Reserve are vital to accomplishing our air refueling mission. Therefore, the ability to recruit for and maintain a strong Reserve component association was a major consideration in this basing action," (USAF, 2015). To this end, AMC developed the fleet basing strategy seen below in Table 1.

Table 1: Fleet Basing Strategy (AMC, 2012)

MOB #	Base Name/Possibility	Owner	Association	Lead MAJCOM	PAA
1	McConnell AFB	AD	AFR	AMC	36
2	Pease	ANG	AD	AMC	12
3	Seymour Johnson AFB	AFR	AD	AMC	12
4	TBD	AD	AFR	AMC	36
5	TBD	AD		PACAF	12
6	Tinker/Westover/Grissom	AFR	AD	AMC	12
7	TBD	AD		USAFE	12
8	TBD	ANG	AD	AMC	8
9	TBD	ANG	AD	AMC	12
10	TBD	ANG	AD	AMC	8
FTU	Altus	AD		AETC	6 to 8

Of the 10 KC-46 MOBs, eight will be based in CONUS, and two will be based OCONUS. Thus, there will be eight associations within the KC-46 fleet – a mix of Classic Associations and Active Associations. This is in stark contrast to the current KC-135 fleet, which contains similar numbers of associations at three Classic Associations and five Active Associations (eight total), but proportionally has significantly fewer units that are at all associated, with 18 CONUS units in the ARC that have no associations at all. With some bases still to be selected as MOBs, it is apparent that the USAF may have adopted some lessons learned from the current KC-135 force structure by keeping the number of KC-46 bases low and compliant with TFI.

Notably, eight of the ten MOBs will have PAA of 12 aircraft or more. Having two ANG units with PAA of eight aircraft is less than ideal for achieving efficiency, but those concerns are partially offset by geographic air refueling coverage that will be provided by those units and the fact that they are Active Associations and not standalone ARC wings, which will increase aircrew availability. In fact, this document notes that a study conducted by AMC/A9 focused on locating tanker units in proximity to regions of high demand for air refueling found the potential for an $80M/year reduction in fuels costs across the CONUS tanker fleet with an optimized basing plan (AMC, 2012). Those savings would partially offset some of the costs incurred by establishing two KC-46 ANG units with 8 PAA.

With the regional demand for air refueling training support staying consistent, the AMC's Lead Command Intent notes the importance of maintaining a geographic balance across the entire tanker fleet to support those steady requirements. However, a glance at the current KC-135 force structure shows that some regions have an abundance of small units that could likely be consolidated without any significant impact to regional capabilities, even with the future KC-46 conversions. In fact, AMC recognizes that 12 PAA units provides cost efficiencies over smaller eight PAA units, without requiring significant additional parking spaces or maintenance facilities to accomplish the mission. Additionally, AMC acknowledges that establishing smaller eight PAA units would result in a proliferation of KC-46 units, further increasing infrastructure, manpower, and sustainment costs as each of those units would require a wing-level structure to support it (AMC, 2012).

Furthermore, AFRC makes similar acknowledgments, with an official at USAF/RE stating that the command would prefer to have all of its unit-equipped tanker units possess 12 or more aircraft (USAF/RE, 2019). This preference appears to be a lesson learned from the mobility community based on the proliferation of the KC-135.

2018 Mobility Capabilities and Requirements Study

After much fanfare, the executive summary for the 2018 MCRS was released in February of 2019. Conducted by USTRANSCOM, the study assessed the ability of the joint mobility force to accomplish its role in the 2018 National Defense Strategy wartime missions based on anticipated Fiscal Year 2023 fleet capabilities and capacities ("MCRS Executive Summary," 2019). Surprisingly, the study's findings were relatively mundane, as its fleet size estimates for each mobility airframe matched what the USAF currently has programmed through 2023. For all tanker aircraft, that number is 479, which is what the tanker fleet will be sized to once the KC-46 is onboarded and the KC-10 is retired ("MCRS Executive Summary," 2019). As a result, the 2018 MCRS did not challenge the status quo, to the surprise of many in the mobility community, including the researcher. Accordingly, its findings do not have any impact on the direction of this research.

III. Methodology

Research Method

The bulk of academic literature is primarily focused on articles published by the USAF or official publications put forth by the DoD, USAF, and subordinate agencies. This research fills an apparent void in the literature by investigating the history behind the KC-135 force structure and quantifying both the operational and fiscal costs associated with the excess infrastructure required to support it. Additionally, this research provides recommendations for an approximate number of ARC KC-135 bases to be considered for consolidation. A single case study research methodology was selected to analyze the KC-135 force structure issue, which is a unique phenomenon inherent to the USAF. Within this single case study, a mix of qualitative and quantitative research methods are selected. Qualitative data was gathered from multiple sources for both historical and current perspectives on the KC-135 force structure issue. Leedy and Ormrod (2016) state, "In qualitative research…we collect various forms of data and examine them from various angles to construct a rich and meaningful picture of a complex, multifaceted situation." Quantitative data is gathered on the annual operating costs of tanker wings of various PAA sizes in order to inform future basing decisions. According to Creswell (2014), quantitative research is an approach for testing theories by examining the relationship among measurable variables, so that numerical data can be analyzed.

Single Case Study

A case study is the study of a particular individual, program, or event for a defined period of time, during which the researcher collects data on the subject(s). Case study data often consists of direct observations, interviews, documents, and past records (Leedy, 2018). Furthermore, Yin (2018), in citing an observer, describes the essence of a case study as an attempt to “illuminate a decision or set of decisions: why they were taken, how they were implemented, and with what result.” Within the context of this research, the researcher analyzes the programmatic decisions that led to the current state of the KC-135 force structure and why those decisions were made. The results of those decisions are captured through personal communications, documents, and other records to both qualify and quantify the impact those decisions are having on the USAF of today. The timeframe of this research will span the entire lifespan of the KC-135 Stratotanker.

However, unlike a typical case study, this research was conducted over the span of less than a year, during which few, if any, observable changes were made to the KC-135 program. Additionally, the research is conducted remotely as the scope of the KC-135 program does not permit “on site” research typically seen in case studies. Thus, the scope and methodology of this case study is much narrower compared to those seen in a typical case study, which often involves years of field research.

Leedy and Omrod (2016) describe how learning more about a poorly understood situation and investigating how a program changes over time as two suitable purposes of a case study. This case study aligns with their assessment as it will focus on investigating how and why the KC-135 program changed over time, as well as creating literature on this little-known topic for future policy recommendations. Based on this, the type of case study being utilized in this research is that of a holistic, single-case design. A single-case design is a type of case study that is analogous to a single experiment, in which there is only one subject of analysis. A holistic design refers to the examination of only the global nature of an organization or program, as opposed to embedded subunits within a program (Yin, 2018). Since the focus of this research is on a single yet broad subject (the entire KC-135 force structure) and not any specific organizations within that subject, the holistic, single-case design is the most applicable case study method for this topic.

Data Collection and Analysis

In addition to literature reviews, primary research information was gathered using official correspondence with AMC A5/8 and the 618 AOC; data collection by the researcher using internet and library sources; data collection by the researcher using the Logistics, Installations, and Mission Support Enterprise View (LIMS-EV) toolset; and finally, data collection from Headquarters AFRC (AFRC/RE) and the ANG Bureau. Official correspondence includes several emails with an official at AMC A5/8 and one thirty-minute phone call with a senior official at the 618 AOC that was recorded. This correspondence was conducted to address the key issues from which the assumptions were made, to obtain the MAF Quarterly Reports, and to be able to cite facts that are well known within the MAF community but are not codified in official documents. The Quarterly MAF Force Structure Reports from AMC A5/8 are essential to understanding the current KC-135 force structure along with being able to determine how much room for consolidation potentially exists within the ARC.

The LIMS-EV toolset is an USAF-level system that permits users to access data and metrics on a number of different logistics factors, such as aircraft and vehicles. Specifically, the researcher is using the Weapon System View to pull historic AA rates for a number of KC-135 units. Ten years' worth of AA rates were gathered for each unit, and the data were analyzed against the various KC-135 units sizes in the ARC to determine if there are any trends between unit size and AA rate. Finally, the researcher obtained financial data from AFRC/RE and the ANG Bureau regarding the annual operating costs of KC-135 wings within the respective commands. These data were necessary to determine if any cost savings could be realized through unit consolidation.

IV. Analysis and Results

Chapter Overview

The first section in this chapter uses the book *Boeing KC-135 Stratotanker* by Robert S. Hopkins III and a number of online sources from AFRC and the ANG to map out the current KC-135 force structure and the history of the decisions that led to this current construct. Additionally, Appendix B (Current Tanker Force Structure Maps) is a useful reference point for visualizing which current tanker bases are assigned to which components, and how many aircraft are assigned to each base.

The second section in this chapter contains a quantitative analysis of AA rates. First, the researcher compares the AA rates of eight TAI units in the ARC against units with larger TAIs using quadratic regression. Following that, the researcher conducts another TAI comparison, this time using a one-tailed t-test. The purpose of these two methods of analysis is to show whether or not it can be statistically proven that ARC units greater than eight TAI in size have higher AA rates, and thus are better able to support operational requirements.

The third and final section in this chapter contains a quantitative analysis of financial data for wing annual operating costs in both AFRC and the ANG. The researcher compares the average annual costs of each wing PAA size (8, 10, 12, and 16) and calculates the potential savings that could be realized through consolidation based upon the perceived capacity for consolidation within each command.

Before beginning the analysis, the researcher would like to clarify the difference between PAA and TAI. PAA refers to the number of aircraft assigned to a unit on paper, and is the baseline for funding that unit receives in a number of areas, including flying hours and manpower. This is why the researcher references PAA as the standard when comparing financial data between wings. TAI, on the other hand, refers to the total number of aircraft *physically* assigned to a unit. A unit may have 12 aircraft TAI, but only ten of those aircraft are PAA. In this instance, the unit has 12 physical aircraft it is responsible for maintaining and flying, but it is only funded for ten of those 12 aircraft. The remaining two aircraft are coded as BAI. Thus, when comparing AA rates between units, the researcher uses TAI instead of PAA because the former is more accurate as to the actual number of aircraft at the base, all of which can be used to fill sorties.

KC-135 Force Structure Background – SAC and AD

The current KC-135 force structure has its history deeply rooted in that of SAC. As previously mentioned in the Background section of this paper, for many decades SAC was the USAF's single manager of the KC-135 fleet, owning more than 600 aircraft at its peak for the purposes of providing air refueling support to strategic bombers (Anderton, 1961). During the SAC years, the KC-135 fleet was constantly on deployments, either in support of SAC bomber deployments or major operations such as the Vietnam War. Additionally, with SAC units constantly realigning and the added fact that some Bombardment Wings had organic air refueling capabilities while others did not, it is extremely difficult to pinpoint which bases had KC-135s at a particular point in time. Yet, with at least 27 Bombardment and Air Refueling Units under its command, SAC certainly had the massive KC-135 fleet spread out widely across the command

(Anderton, 1961). With SAC's mission at the forefront of national interests during the Cold War, the KC-135 remained entirely within the command's control across the globe as its presence was essential to supporting the airborne portion of the nuclear triad. However, with the end of the Cold War, the USAF went through a massive reorganization in 1992, which resulted in the deactivation of SAC and the precursor to AMC, Military Airlift Command (MAC). Air Combat Command (ACC) and AMC were thus born from the remnants of SAC and MAC, respectively. Within this fundamental realignment of the USAF, the bomber and tanker forces were permanently divorced from one another, with ACC absorbing the bomber fleets and AMC gaining the tanker fleets (Owen, 2013.)

The stand-down of SAC is perhaps the most significant milestone in the history of the KC-135 force structure. While many KC-135s would remain at the same bases both before and after the deactivation of SAC, the transfer of ownership to AMC (and by extension, ANG and AFRC) fundamentally changed how the aircraft was to be employed, and ultimately where it would be based in the future. AMC directly took control of three major SAC tanker bases – Grand Forks AFB, ND; McConnell AFB, KS, and Fairchild AFB, WA (Meintel, 2016). These remained AD units. While Grand Forks AFB no longer flies KC-135s and is now part of ACC, McConnell and Fairchild AFBs remain as large tanker wings within AMC to this day. Elsewhere within the Active Component, the 306th Strategic Wing at RAF Mildenhall, a SAC unit, stood down and the 100 ARW assumed responsibility for the KC-135 mission there under the purview of United States Air Forces in Europe (USAFE) in 1992. Likewise, in the Pacific theater the 376th Strategic Wing at Kadena Air Base also stood down, and the 18th Wing under

Pacific Air Forces (PACAF) assumed responsibility of the KC-135 mission in 1991 (Hopkins III, 1997). Finally, to round out the impact of the SAC deactivation on the Active Component, in 1996 the 91st Air Refueling Squadron transferred from Malmstrom AFB (formerly a SAC base that was owned by AMC at the time) to MacDill AFB, where the 6 ARW was established (Hopkins III, 1997). Thus, the majority of AD bases that operate the KC-135 today were conversions from SAC, with the exception of MacDill AFB, which adopted the air refueling mission set a few years later.

KC-135 Force Structure Background – AFRC

Contrary to the relatively simple history of the current AD KC-135 force structure, explaining the ARC force structures is much more complicated. As with the AD bases, it is best to start by tracing lineages back to SAC, the birthplace of the KC-135. Starting with AFRC, Grissom ARB in Indiana (the largest AFRC tanker base today) was a SAC conversion that stood down its AD mission in 1993. The following year, ownership transferred to AFRC and the unit was redesignated as the 434 ARW (Hopkins III, 1997). Similarly, March ARB, CA was also a SAC conversion that initially fell under AMC. The 1993 BRAC round chose March for realignment, resulting in a number of moves that ultimately led to the 452 AMW being stood up at March ARB in 1994, with a full conversion to AFRC two years later ("History of March," 2018). In 2010, March ARB became a Total Force unit with the activation of the 912th Air Refueling Squadron, an Active Associate unit.

The final SAC holdover within the AFR, Beale AFB, has a more complicated history. In 1992, the KC-135s at Beale transferred to AMC under the 350th Air Refueling

Squadron. However, they were not to remain there long, as in 1994 that unit transferred to McConnell AFB, where it remains today (Hopkins III, 1997). Thus, Beale AFB was left without a tanker presence until 1998, when AFRC KC-135s at McClellan AFB, CA where transferred to Beale AFB as a result of the 1993 BRAC. The 940 ARW was activated under AFRC, but would only remain there for ten years as the 2005 BRAC removed the tanker mission at Beale AFB and sent the units eight KC-135Rs to the Tennessee ANG in order to replace their aging KC-135Es (BRAC, 2005). The 940 ARW became the 940th Wing, and was associated with the host ACC unit at Beale AFB, until 2016 when AFRC brought back the KC-135s and re-established the 940 ARW ("KC-135 Tanker Mission Returns to Beale," 2016). The history of Beale illustrates the problem of proliferation in the KC-135 force structure. Somehow AFRC was able to undo the decisions of the 2005 BRAC and re-establish the air refueling mission at Beale AFB. Either the 2005 BRAC decision should not have been made, or the USAF could have saved money by finding a different home(s) for the eight KC-135s currently at Beale – preferably one that was already operating the airframe.

The remaining four unit-equipped AFRC tanker bases do not trace their history to SAC, as they did not acquire their KC-135s until the mid-1990s or later, and represent the proliferation of the Stratotanker across the Total Force and CONUS. The 507 ARW at Tinker AFB, OK has a long history at that base, but it did not acquire KC-135s until 1994 when it converted from an AFR fighter unit, with the ARW being stood up three years later (Hopkins III, 1997). At Seymour Johnson AFB, NC, the 916 ARW stood up in 1995 and converted from KC-10s to KC-135s. It had previously been an AFRC Air Refueling Group associated with the 4th Fighter Wing at Seymour Johnson ("916th Air Refueling

Wing History," 2006). The 916 ARW gained an Active Associate unit, the 911th Air Refueling Squadron, in 2008, making it the first Total Force AFR tanker unit, with the 452 AMW at March being the second.

The air refueling unit at Niagara Falls Air Reserve Station shares a similar history with the 940 ARW at Beale AFB. The current unit, the 914 ARW, traces its lineage to the 107 ARW, which stood up in 1995 to fly the Stratotanker (Hopkins III, 1997). However, just ten years later, the 2005 BRAC decided that the 107th would convert from air refueling to airlift, and the unit became an associate of the 914 Airlift Wing (AW) in 2008, all under the umbrella of AFRC. The 107th's KC-135Rs would go on to replace the aging KC-135Es at the 101 ARW in Bangor, Maine (BRAC, 2005). In what appears to have been either a short-sighted decision by the 2005 BRAC Commission or another example of excess unit conversions, in 2017 the 914 AW was redesignated as the 914 ARW and the KC-135 once again returned to Niagara Falls, not even ten years since it departed ("914 ARW Short History," 2018).

The final AFCR KC-135 unit, the 459 ARW at JB Andrews, MD, previously operated the C-141 out of Andrews until 2003, when it converted to KC-135s prior to the retirement of the C-141 ("459 ARW Fact Sheet," 2016). This is an example of a Reserve unit staying in place while completely changing missions sets. It is likely that this conversion occurred to keep the unit in place at Andrews, in lieu of any tangible operational need as there was no history of air refueling at this location. Air refueling support of Operation Noble Eagle, the post-9/11 mission to defend America from airborne threats (Kreisher, 2007), may have factored into this decision as Andrews is in close proximity of the nation's capital. When discounting the refueling wings at Beale

AFB and Niagara Falls, the 459 ARW at JB Andrews is the youngest air refueling unit within AFRC.

In summary, there are three AFRC KC-135 units – the 434 ARW at Grissom, the 452 AMW at March, and the 940 ARS at Beale - that can trace their history at their current location back to the days of SAC. The four remaining units all represent post-Cold War conversions to the KC-135 from different airframes, but share the commonality of all being historically AFRC units.

KC-135 Force Structure Background - ANG

Compared to the AFRC KC-135 Force Structure, the ANG reality is even more complex, as there are 18 individual units currently operating the airframe across the Guard community. Again, it would be best to start with those units that can trace their history to SAC. The 121 ARW at Rickenbacker Air National Guard Base, OH was the first ANG unit to convert to the KC-135 under the purview of SAC. This occurred in 1975, when the unit was named the 160th Air Refueling Group (AREFG) after losing its A-7D Corsair IIIs. In 1993, following the end of the Cold War and SAC, the unit designation changed to the 121 ARW, as it remains today (Hopkins III).

The 157 ARW at Pease Air National Guard Base, NH, adopted the KC-135 mission shortly after Rickenbacker. This unit converted from C-130s to KC-135s in 1975, which lead to the creation of the 157 AREFG, the predecessor to the 157 ARW, which formally was created in 1995 (Hopkins III, 1997). In 2009, Pease became one of the first Guard units with an Active Associate unit when the 64 ARS was activated ("64th ARS Activated," 2009). This association was a key factor when the USAF decided to designate Pease as one of the first three KC-46 units. The 101 ARW at Bangor Air National Guard Base, Maine, also numbers among one of the oldest KC-135 units in the Guard. It was established as a Guard unit at Bangor in 1976, and operationally was attached to SAC (Hopkins III, 1997). When SAC stood down, the unit was then gained by AMC but otherwise remained in place, where it remains today.

Another long-time tanker unit, the 134 ARW at McGhee-Tyson Air National Guard Base, TN, was established as an AREFG 1976 when it converted from KC-97 aircraft to KC-135s, and was gained by SAC as a Guard unit ("Base History," 2018). The unit changed to the 134 ARW in 1995 during an ANG reorganization, which also affected Pease and other units with regards to designations. The unit has remained unchanged since 1995. Much like the 134 ARW, the 128 ARW at General Mitchell Air National Guard Base, WI, converted from KC-97s to KC-135s in 1977, when it was an AREFG at the time (Hopkins III, 1997). Additionally, the ARW became official in 1995 as with the other ANG units during the reorganization. In the same vein, the 171 ARW at Pittsburgh International Airport, PA was gained by SAC in 1977, and converted to the Stratotanker from the KC-97 (Hopkins III, 1997). The unit converted from an AREFG to an ARW in 1992 as SAC was deactivated.

Three more SAC holdovers exist within the ANG KC-135 community. The 161 ARW at Phoenix Sky Harbor International Airport, AZ, also converted from KC-96s to the Stratotanker in 1977 per direction from SAC (Hopkins III, 1997). The change from 161 AREFG to the 161 ARW occurred in 1995. The 190 ARW out of Forbes Field, KS dates back to 1978, with a similar change from the 190 AREFG to the 190 ARW in 1995 (Hopkins III, 1997). The 190 ARW is of special note as it is one of three ANG tanker units to possess a dozen or more aircraft, which it gained by absorbing the KC-135s from the 184 ARW, a now-defunct ANG unit that operated out of McConnell AFB (“Brief History of the 184 IW,” 2018). Finally, the 151 ARW at Wright Air National Guard Base, UT, was gained by SAC in 1978, driving yet another conversion from the KC-97 to the KC-135, with a similar name change in 1995 (Hopkins III, 1997). In summary, eight ANG units adopted the KC-135 mission between 1975 and 1978 under the purview of SAC, and have remained active since then with no breaks in service. With the history of those units briefly summarized it is time to look at the nine remaining ANG tanker units.

The next round of ANG units came into the KC-135 community in the years following the end of the Cold War and SAC. The first of these units was the 108th Wing at what is now known as Joint Base McGuire-Dix-Lakehurst. The 108th was for a long time a Tactical Fighter Wing until 1991, when it converted to the KC-135, likely gaining the aircraft from a soon-to-be defunct SAC base (Hopkins III, 1997). The 186 ARW out of Meridian Regional Airport, MS (also known as Key Field) shares a similar history. The Mississippi ANG unit there operated a number of different fighter aircraft until 1992, when its RF-4C Phantom IIs were retired and the KC-135 came to Meridian (Hopkins III, 1997). Interestingly, the unit began converting to the C-27 Spartan in 2011, but the cancellation of that program drove the unit to revert back to operating the KC-135, which had briefly departed Key Field (“History of the 186th,” 2013).

Of the remaining current KC-135 units, another four of them came into existence in the same early-to-mid 1990s timeframe. The 155 ARW at Lincoln Air National Guard Base, Nebraska began its tanker conversion in 1993 after having flown numerous fighter aircraft over the previous decades under a different unit designation. The conversion completed in 1995 and the wing was formally established (Hopkins III, 1997). Meanwhile, the 154th Wing at Joint Base Pearl Harbor-Hickam, Hawaii has a larger mission set than most other ANG tanker units, and is also operationally gained by PACAF. To start, its designation as a Wing and not an ARW shows that it operates more aircraft than just the KC-135. As one of the largest wings in the ANG, it also operates the F-22 and C-17. The KC-135 came to the 154th Wing in 1993 as the 203 ARS was activated and the air refueling mission set was added to the unit, which was already operating tactical fighters and a cargo aircraft (Hopkins III, 1997). Interestingly, the history of the KC-135 at Hickam actually dates back to the 1970s, when they were on constant rotation at the base as part of SAC's mission set.

Finally, the 117 ARW out of Sumpter Smith Air National Guard Base in Birmingham, Alabama shares a similar history, tracing its roots back to fighter aircraft under Tactical Air Command. In 1994, the base's RF-4C aircraft were retired and the 117 ARW was activated, with the KC-135 following shortly after (Hopkins III, 1997). Much like Pease ANGB and March ARB, the Birmingham unit hosts an active associate unit, the 99 ARS (Krenke, 2008). Interestingly, this base was considered for closure under the 2005 BRAC, but the decision was later reversed (BRAC, 2005). Up in the far north of Alaska, 168th Wing operates out of Eielson AFB. Its history there is not quite the same story as the other post-Cold War KC-135 units. Four Illinois ANG KC-135s came to Eielson AFB in 1986 and operated under the banner of the 168 ARS, whose parent headquarters was at Elmendorf AFB, all under the command of PACAF. It is not clear when exactly the 168 ARS began to operate more than just four KC-135s, but in the wake of the end of the Cold War, the unit's mission size grew and the 168 ARW was officially established in 1992 (Hopkins III, 1997). In 2016, the 168 ARW was redesignated as the 168 Wing due to a dual-mission set ("Alaska ANG Unit Redesignated," 2016).

In this second set of KC-135 wings within the ANG, there are six units that became wing-level organizations in the years immediately following the end of the Cold War and the existence of SAC. All of these units gained their aircraft in the wake of SAC's demise, where that command's massive KC-135 fleet was dispersed across the USAF, primarily to AMC-gained units. This event is a milestone in the proliferation of the KC-135, though it was arguably necessary as the USAF was undergoing a massive reorganization at the time and had to put these aircraft somewhere. In deciding these locations, the USAF maintained some consistency by keeping the bulk of the KC-135s that belonged to the ANG pre-reorganization within the Guard afterwards. The final three ANG units, which will now be covered, represent the further expansion of the KC-135 community within the ANG, starting in 1999.

The 126 ARW at Scott AFB, IL has a long history, but has only been at its current location since 1999. The unit took possession of the KC-135 back in 1976 when it was stationed out of O'Hare International Airport in Chicago, Illinois (Hopkins III). The 1995 BRAC disbanded the 126 ARW's sister wing at O'Hare, the 928 AW, and directed the 126 ARW to relocate to Scott AFB ("126 ARW Chronological History," 2011). While this was a missed opportunity for consolidation within the KC-135 community, the move did make logical sense – the Illinois ANG got to retain their tankers, and without the 126 ARW today, Scott AFB would be without any wide-body aircraft and would have a very small operational footprint to complement AMC headquarters located across the airfield. However, with the Illinois ANG also operating a small fleet of 8 C-130H aircraft out of Peoria under the 182 AW, the question must be asked as to whether two small, geographically separated ANG mobility wings within a single state is necessary, or if an opportunity for consolidation was missed.

The 185 ARW out of Sioux City, Iowa has a long history, but it is a relative newcomer to the KC-135. For years, the ANG unit out of Sioux City operated fighter aircraft, with the latest being the F-16, which arrived in 1991. But in 2003, the USAF decided that the unit should convert to the KC-135, representing a brand-new operating location for the airframe ("History of the 185th," 2010). It is unknown to the researcher as to what decisions drove the F-16 to depart Sioux City, but this example represents that creation of an entirely new mission city at a Guard unit to replace the outgoing mission and to keep the unit open. If converting the unit to a different fighter aircraft was not tenable, then perhaps closing the unit would be the next-best economical choice, despite the Congressional opposition that would result. There was no obvious strategic need to put the Stratotanker in Sioux City, as there is no history of tanker aircraft operating in that state. Thus, it would seem apparent that this move was executed solely to keep the 185th in place for the sake of the Iowa ANG and the state. Meanwhile, the eight KC-135s that did come to Sioux City could have been sent to previously-established tanker wings.

The final ANG unit to be covered is the 127th Wing out of Selfridge Air National Guard Base, MI. The 127th, like most ANG units, has a long history within its home state, but prior to 2007, the 127th operated only fighter aircraft and C-130s. The 2005 BRAC directed the unit to convert from C-130s to KC-135s, setting up the establishment of the 127th Air Refueling Group in September of 2007 ("127th Wing History, Lineage, and Commanders," 2018). In an interesting twist, at this time there was also an AFRC wing at Selfridge – the 927th Air Refueling Wing, which had been operating the KC-135 there since 1992 (Hopkins III, 1997). At the direction of BRAC, the KC-135s transferred from the 927 ARW to the 127th Wing (that is, from AFRC to ANG), with the 927 ARW relocating its personnel to MacDill AFB to become the associate unit with the host 6 AMW (BRAC, 2005). Thus, Selfridge's history with the KC-135 is more in-line with the other post-Cold War tanker units. It is also worth noting that since Selfridge used to play host to two wings and three different airframes, this may suggest that there is real estate at the base to absorb a larger mission set in the future.

KC-135 Force Structure Background - Summary

Research found that the vast majority of KC-135 units in the USAF have a long history of operating out of their current locations. Even those with relatively recent histories date back to the years immediately after the Cold War, which saw the USAF experience a massive reorganization in light of geopolitical changes. Only five extant units have histories that raise questions as to why certain decisions were made regarding their continued existence. Two of these units, the 459 ARW out of JB Andrews and the 185 ARW out of Sioux City, experienced conversions to the air refueling mission set in the early 2000s despite no history of conducting that mission at either location. Both of these moves seem to have been largely driven by a perceived need to keep the units in place instead of any pressing operational need. This may or may not have been further influenced by the fact that both units are in the Reserve Component, where personnel do not move as frequently as in the Active Component, thus leading to an increased prevalence for "homesteading" – that is, military personnel remaining in one location for an extended period of time.

The 940 ARW at Beale AFB and the 914 ARW at Niagara Falls were both victims of realignment by the 2005 BRAC, losing the air refueling mission set shortly after. However, as noted earlier, the USAF forced the KC-135 back to both locations not even a decade later, which demonstrates that BRAC decisions are not necessarily permanent, especially if the host installation remains intact. The deep level of research conducted by the 2005 BRAC would suggest that those in the commission did not see a pressing operational need to retain the KC-135 at either location, which is why they were directed to relocate. If that is the case, then why did the USAF bring the airframe back to those locations so quickly? Such decisions should be based on operational requirements, and not the needs of the individual units or congressional districts. If AFRC had not brought back 16 total KC-135s to Niagara and Beale, it would have two fewer unit-equipped KC-135 units, but the five remaining units could have potentially been larger, more efficient, and better equipped to handle operational taskings if they instead absorbed those 16 KC-135s. Alternatively, the decisions to stand up those units again may have been driven by geographic alert requirements, though the researcher was unable to find any decision memorandums on record regarding those moves. If that is the case, then it is the researcher's opinion that the 2005 BRAC made an ill-informed decision and should have better researched the military necessity of those two units.

The fifth unit, 126 ARW at Scott AFB, is the least controversial with regard to the decisions that led to its current state. While this unit has only been at Scott since 1999, it has a much longer history of operating the KC-135 at its previous location of O'Hare International Airport. The Illinois ANG was certainly within its right to retain and relocate its only tanker unit as O'Hare became too large and crowded for a military presence. It may be up for debate as to where this unit should have been relocated, especially with respect to its sister wing in Peoria, but it is clear that the 126 ARW has a valid and historical operational mandate.

The proliferation of the KC-135 across the USAF is not as great as the researcher first expected. The vast majority of the current units were established in two waves – the 1970s and 1990s – with four recent additions since then. In light of this, it is still worth evaluating whether or not there were missed opportunities for consolidation in the two most recent decades. AMC A5/8, which oversees the programming for AMC, agrees that the decisions to bring the KC-135 to the units mentioned above has contributed to the proliferation of the Stratotanker since September 11, 2001. However, with the current state of USAF programming and Congress' reluctance to let units close outside of a BRAC, these moves were all driven by transfers of C-130s and C-17s to and within the ARC that required units losing their aircraft to gain a new mission set in return (AMC A5/8, 2018).

Essentially, the USAF's hands are tied when it comes to such transfers. While the service may have some say in where a particular airframe will go, it is nearly powerless to unilaterally decide to end operations at any one base. If a mission set (e.g. airlift or air refueling) is to be moved from one base to another, Congress will almost certainly require another mission set to take its place to at least partially make up for the loss in personnel and prestige. This can either be a mission set that already exists at a particular base, or something entirely new. Simply moving a mission set and closing down a base is an event rarely seen outside of a BRAC. According to AMC A5/8, from the programmatic standpoint, it is very difficult for the USAF to take down an ARC “flag” without considerable Congressional backlash. In this context, “flag” is a term used to represent a numbered unit. To mitigate this backlash, the USAF, working closely with AFRC and ANG, has stood-up many of these tanker units with eight aircraft to ensure no flag came down (AMC A5/8, 2018). This is largely why there are 19 tanker units across the ARC today with ten or fewer aircraft on their flight lines – it was the easiest way to preserve their flags. As the lead command, AMC has desired to consolidate these units in the past, but political constraints have stood firmly in the way of doing so.

This reality is not likely to change any time soon. The USAF can make a very compelling argument for a planned force structure change, but even the best arguments can fail to sway the minds of those Congress members tied to the district(s) that will be impacted by such changes. This problem is not unique to the USAF. As such, BRAC remains the best venue for force structure changes that result in base closures, as it is a multi-lateral commission operating on the authority of Congress itself. The 2005 BRAC made a number of recommendations to consolidate the tanker force structure, but some have since been undone. Below is a brief summary of all KC-135 force structure-related recommendations from the 2005 BRAC:

- (Struck Down - Consolidation) Distribute all KC-135Rs from the 117 ARW in Birmingham to Bangor, McGhee-Tyson, and Phoenix. This would have resulted in the closure of Birmingham Air National Guard Station and would have potentially increased the fleet sizes at the other three locations, assuming the inbound KC-135Rs were not meant to replace retiring aircraft.

- (Consolidation) Realign Beale AFB. Distribute all KC-135R/Ts from the 940 ARW at Beale AFB to the 134 ARW at McGhee-Tyson. This was undone when the USAF brought the Stratotanker back to Beale in 2016.

- (Intrabase Transfer) Realign Selfridge Air Reserve Base

- (Intrabase Transfer) Realign March ARB. Similar to Selfridge ARB, this move transferred KC-135 R/Ts from the 163 ARW, an ANG unit at March, to the AFR's 452 AMW, also at March, along with the ANG units at Pease and McGuire. The 163 ARW stood down as a result.

- (Consolidation) Realign Robins AFB. This distributed the KC-135R/Ts belonging to the 19 ARG (an ANG unit) across the USAF, and stood down that unit as well.

- (Consolidation) Realign Niagara Air Reserve Station. Distributed all KC-135R/Ts from the 107 ARW at Niagara to the 101 ARW at Pease. This was undone when the USAF brought the Stratotanker back to Niagara in 2016.

- (Consolidation) Realign Grand Forks AFB. This distributed all KC-135 R/Ts from the 319 ARW at Grand Forks AFB to various units across the Total Force. The 319 ARW stood down as a result.

- (Consolidation) Realign McConnell Air National Guard. This distributed all nine KC-135 R/Ts at the 184 ARW out of McConnell AFB (an ANG unit) to the 190 ARW at Forbes Field. The 184 ARW stood down as a result.

- (Consolidation) Realign Portland International Airport Air Guard Station. This distributed all KC-135 R/Ts at the 939 ARW out of Portland to the 507 ARW at Tinker AFB (ANG to Reserve). The 939 ARW stood down as a result.

The 2005 BRAC thus made a modest effort to consolidate the KC-135 force structure, with seven units giving up their aircraft and being deactivated as a result. Two additional units were stood down, but their aircraft transfers largely stayed within the confines of the same base, with the recipients being units that were already operating out of there, only under a different component. This effort towards consolidation was diminished when two of those seven units that were deactivated were brought back into the fold in 2016, which was clearly not foreseen by the 2005 BRAC.

If more changes like these are to be made to the KC-135 force structure, it must come through a new BRAC, as only that commission has the political clout that is required to make such recommendations tenable before Congress. Ideally, the next BRAC will search for more targets of opportunity for consolidation within the KC-135 community, mostly via the smaller 8 PAA units in the ARC, which are numerous. This research will not recommend specific units for consolidation out of respect for those units and for fear of creating a perception of bias. It will, however, recommend a target number of units for consolidation both within the AFR and ANG, based upon an analysis of wing operating costs and room for expansion at existing bases. First, the researcher will describe how the current KC-135 force structure impacts the USAF both operationally and fiscally.

Aircraft Availability Rate Quadratic Regression

This next section will contain a quantitative analysis of the AA rates of various KC-135 units, comparing them between units of different sizes. The researcher accessed AA rates from LIMS-EV, an USAF-level system that permits users to access data and metrics on a number of different logistics factors, such as aircraft and vehicles. Specifically, the researcher used the Weapon System View to pull historic AA rates for a number of KC-135 units. In this view, data requests can be sorted by platform type, Mission Design Series (MDS), COCOM, MAJCOM, installation, and the specific metric being measured. The AA rate is an expression of the percentage of a given fleet that is available on any given day to execute the flying program. It is expressed as the total time all aircraft are possessed by the unit minus the time accounted to depot possession or not missional capable status, during which aircraft cannot accomplish any of their assigned missions. Below is a graphic of the AA rate formula:

$$\textbf{Aircraft Availability} = \frac{(\textbf{MC Hours})}{(\textbf{TAI Hours})} \times \textbf{100}$$

Figure 1: Aircraft Availability Equation (AF TTP 3-3, 2015)

In this formula, "MC Hours" are Mission Capable Hours and "TAI Hours" represent the total possessed hours in the fleet over the specified timeframe. The result is expressed as a percentage, with a higher number indicating more aircraft availability, which is the desired result in any flying unit. The researcher hypothesized that units with more aircraft assigned would have higher AA rates due to having access to a larger pool of aircraft than smaller units would. In such units, the mathematical impact to AA of having one aircraft down for maintenance is less than that in a smaller unit.

The researcher first attempted to pull AA rates for AD KC-135 units, but ran into several issues. First, no data existed in LIMS-EV for the units at Kadena AB or Mildenhall AB. Additionally, the units at MacDill, Fairchild, and McConnell AFBs all possess a mix of KC-135R and KC-135T aircraft. Both the R and T models are tracked separately in LIMS-EV, meaning each data pull for those bases produced two AA rates – one for the R model, and one for the less numerous T model. Further complicating that is the fact that the total number of each model of KC-135 assigned to those three bases vary year-to-year due to constant tail swaps between those bases. Finally, Fairchild and McConnell AFBs possess significantly more KC-135s than any other tanker base in the total force, thus making any comparisons to MacDill AFB or any total force tanker unit unnecessary. As such, the researcher decided not to calculate the cumulative AA rates for the R and T models in the active KC-135 force. It is worth noting that the ANG does possess KC-135Ts; however, they do not mix R and T models within the same unit.

Following this, the researcher next pulled AA rates for KC-135 units in the ANG, with the exception of the 108th Wing at JB McGuire-Dix-Lakehurst due to incomplete data in LIMS-EV. The researcher pulled ten years' worth of AA data (FY09 through FY18) on these units, with each unit having an overall AA rate calculated for each of the ten years. Unexpectedly, the researcher discovered that most units had fluctuating TAI amounts across the timeframe. For example, the 134 ARW out of McGhee-Tyson is currently a 10 TAI unit, but had anywhere from nine to 12 TAI during the ten-year look. The researcher originally intended to evaluate each individual unit based on its current TAI and historical AA rates; however, due to this frequent variation in TAI, that link cannot be logically made on a unit-by-unit basis. Instead, the researcher chose to evaluate AA rates across the various TAI sizes found in the data pull. That data is summarized in the table below:

Table 2: ANG TAI vs AA Rate Summary (LIMS-EV, 2019)

TAI	Avg AA Rate	TAI Count
6	38.37	1
8	62.84034483	58
9	65.26217391	46
10	60.32631579	19
12	65.20304348	23
16	69.9975	12
18	62.01666667	3

The "TAI" column represents the seven different TAI counts observed across all ANG KC-135 units from FY09-FY18, with six being the lowest and 18 being the highest observed TAI. The "Avg AA Rate" column displays the averaged AA Rates for the respective TAI across the entire timeframe. Finally, the “TAI Count” column displays the number of times that specific TAI amount was observed. For example, a TAI of six aircraft was only observed once (the 126 ARW in 2009), while a TAI of eight aircraft was observed the most times at 58, as eight aircraft is the most common fleet size in the ANG.

Next, the researcher graphed the data presented above to show how TAI and AA rates are correlated:

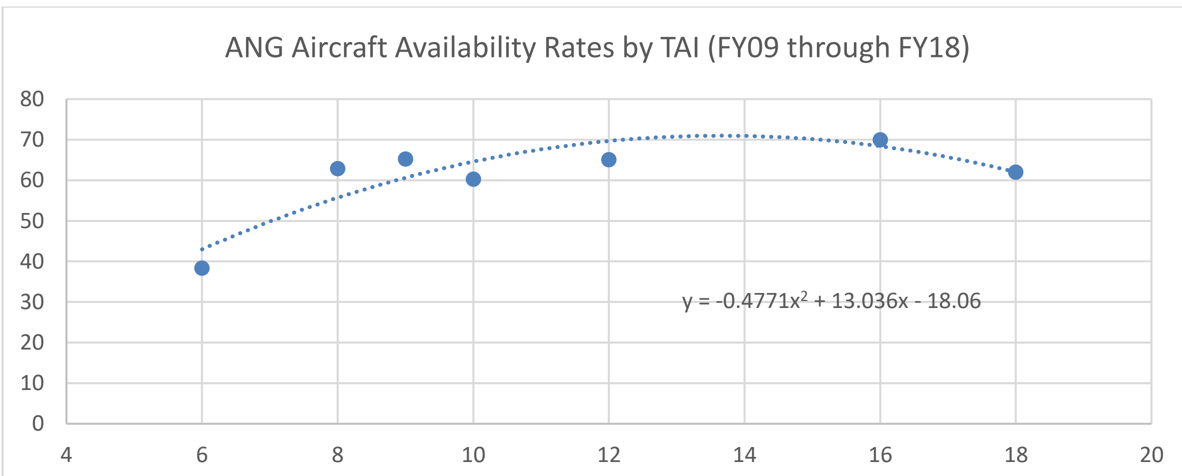


Figure 2: ANG AA Rates by TAI (LIMS-EV, 2019)

Note that TAI amounts are along the x-axis, and AA rates are listed in 10 percent increments along the y-axis. A polynomial (quadratic equation) line fit was used to create the trendline in the above figure due to the natural curve in the data points. From the graph, it is apparent that six TAI resulted in the lowest AA rates among ANG KC-135 units, while 16 TAI resulted in the highest average rates. However, it is important to consider that there was only one observation for six TAI across the ten years of data, thus the significantly lower AA rate. The trend line on the graph shows that AA rates trend upwards as TAI increases to 16 aircraft, with an unexpected downturn from 16 to 18 TAI. Much like the six TAI range, 18 TAI units only had three data points across the entire range, likely skewing the AA rate lower than if there had been more observations. Despite the small number of observations at either extremity of the data, there are enough data points for 8, 9, 10, 12, and 16 TAI units to build a reliable model for AA rates as a function of TAI. The model is designated by the equation $y = -0.4771x^2 + 13.036x - 18.06$, with the variable 'x' indicating TAI while the output 'y' is the modeled AA rate. For example, by substituting 'x' with 12 (one of the TAI amounts observed), the expected AA rate is calculated to be 69.66 percent. Looking at the graph in Figure 2, this is the y-value of the trend line as it crosses the x-value of 12. Note that the actual observed average AA rate of 12 TAI units is 65.2 percent, as observed in Table 2. The trend line indicates what the expected AA rate would be given a specific TAI amount, and is derived from all the data points included in the model.

The R^2 value for the quadratic ANG model is .784. The adjusted R^2 value is .676. This value measures the amount of data points that can be explained by the model. The adjusted R^2 value indicates that 67.6 percent of the variability in the observed ANG KC-135 AA rates can be explained by the model produced above. The higher the R^2 value is, the higher the confidence in the model's ability to account for variability in the data (Weir, 2018). An adjusted R^2 value is used in lieu of the default R^2 value as it accounts for the number of terms in the equation. The more terms there are in an equation, the higher the R^2 value will be, thus potentially inflating the result. The adjusted R^2 accounts for this and will always be lower than the default R^2 value. Given this number, the researcher is moderately confident that TAI positively correlates with AA rates in ANG KC-135 units. What this means for the ANG is that KC-135 units of larger sizes will tend to have higher AA rates, and thus a higher percentage of their fleet available for flying training sorties or missions. While it is true that eight TAI units outperformed ten TAI units when it comes to AA, units with nine, 12, or 16 TAI averaged 65 percent or higher AA rates across the ten-year timeframe. Nine TAI units likely outperformed eight TAI units due to the presence of one BAI aircraft, which is not taskable. The remaining eight aircraft in these units are all PAA, just like in an eight TAI unit. With the same number of PAA aircraft, nine TAI units are tasked and manned just like an 8 TAI unit, with the difference being that one spare aircraft, which provides extra flexibility with flying and maintenance scheduling.

The researcher ran the same comparison between AA rates and TAI for all KC-135 units in AFRC. The researcher pulled ten years' worth of AA data (FY09 through FY18) on these units, with each unit having an overall AA rate calculated for each of the ten years. The 940 ARW at Beale and the 914 ARW at Niagara only had four valid data points between them due to the fact that these units only recently were re-established as operational wings. All five of the other units had ten data points each, though much like in the ANG, some of these units had fluctuating TAI amounts across the timeframe. For example, the 507 ARW out of Tinker is currently an eight TAI unit, but had 12 TAI from FY09 through FY13. Just as with the ANG data set, the researcher chose to evaluate AFRC AA rates across the various TAI sizes found in the data pull. That data is summarized in the table below:

Table 3: AFRC TAI vs AA Rate Summary (LIMS-EV, 2019)

TAI	Avg AA Rate	TAI Count
7	47.40	1
8	63.52	18
12	69.20	9
14	71.69	5
15	69.81	3
16	69.45	18

The “TAI” column represents the six different TAI counts observed across all AFRC KC-135 units from FY09-FY18, with seven being the lowest and 16 being the highest observed TAI. The “Avg AA Rate” column displays the averaged AA Rates for the respective TAI across the entire timeframe. Finally, the “TAI Count” column displays the number of times that specific TAI amount was observed. For example, a TAI of seven aircraft was only observed once (the 940 ARW in 2016, its first operational year after reactivating), while a TAI of eight and 16 aircraft were observed the most times at 18 each. While there is only one current 16 TAI KC-135 unit in AFRC, the 916 ARW had 16 aircraft through FY16, until it decreased to 12 TAI.

Next, the researcher graphed the data presented above to show how TAI and AA rates are correlated in AFRC KC-135 units (see following page):

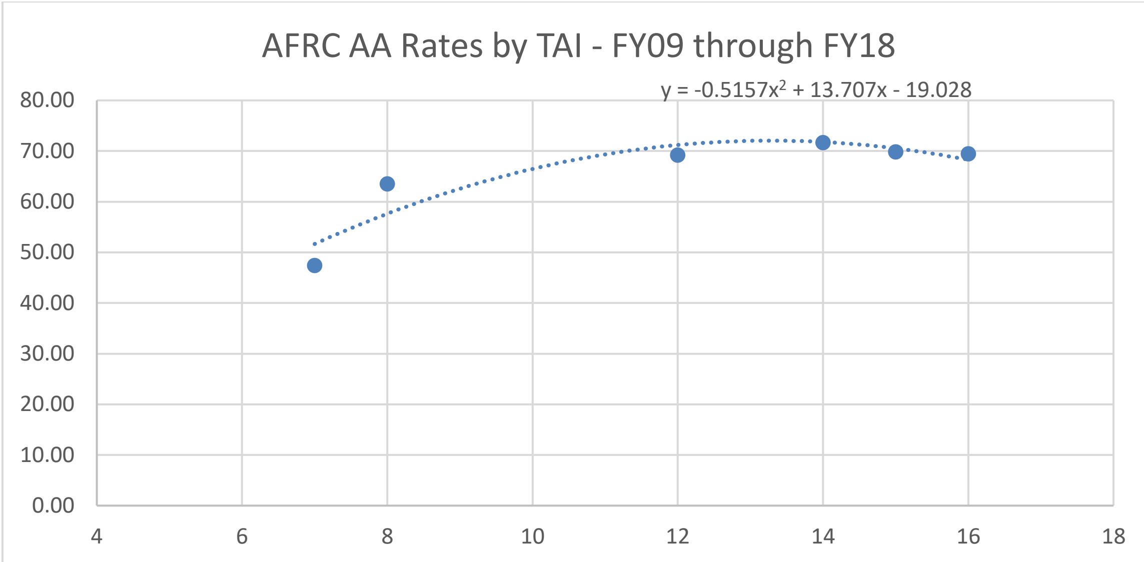


Figure 3: AFRC AA Rates by TAI (LIMS-EV, 2019)

Note that TAI amounts are along the x-axis, and AA rates are listed in 10 percent increments along the y-axis. A polynomial (quadratic equation) line fit was used to create the trendline in the above figure due to the natural curve in the data points. From the graph, it is apparent that seven TAI resulted in the lowest AA rates among AFRC KC-135 units, while 14 TAI resulted in the highest average rates. Just as it was in the ANG data set, in AFRC there was only one observation for the lowest TAI amount (seven) across the ten years of data, thus the significantly lower AA rate for that amount. The trend line on the graph shows that AA rates trend upwards as TAI increases to 16 aircraft, although rates peak at 14 TAI. Contrary to the ANG data, the AFRC data has the majority of data points towards either extreme of TAI counts, with more than half of the data points occurring at either 8 and 16 TAI.

The model for AFRC units is designated by the equation $y = -0.5157x^2 + 13.707x - 19.028$, with the variable ‘x’ indicating TAI while the output ‘y’ is the modeled AA rate. For example, by substituting ‘x’ with 12 (one of the TAI amounts observed), the expected AA rate is calculated to be 71.19 percent. Looking at the graph in Figure 2, this is the y-value of the trend line as it crosses the x-value of 12. Notice that the actual observed (per Table 2) average AA rate of 12 TAI units is 69.20 percent, which is a couple of points lower than the trend line.

The R^2 value for the quadratic AFRC model is .8592. The adjusted R^2 value is .7652. This value measures the amount of data points that can be explained by the model. The adjusted R^2 value indicates that 76.5 percent of the variability in the observed AFRC KC-135 AA rates can be explained by the model produced above. An adjusted R^2 value is used in lieu of the default R^2 value as it accounts for the number of terms in the equation. The more terms there are in an equation, the higher the R^2 value will be, thus potentially inflating the result. The adjusted R^2 accounts for this and will always be lower than the default R^2 value. Given the adjusted R^2 value, the researcher had a moderately high degree of confidence that TAI positively correlates with AA rates in AFRC KC-135 units. The most likely reason for why the AFRC model has a higher adjusted R^2 than the ANG model is that the data points for the AFRC model are concentrated towards the TAI extremes, while the ANG data points are concentrated towards lower TAIs.

Given the AA rates observed for the various AFRC units, the researcher can state with high confidence that TAI positively correlates with AA rates all the way from seven to 16 TAI. What this means for AFRC is that KC-135 units of larger sizes will tend to have higher AA rates, and thus a higher percentage of their fleet available for flying training sorties or missions. Units that possessed between 12 and 16 aircraft had very similar averaged AA rates, some 6.5 percentage points higher than the average rates for 8 TAI units. While eight TAI units in ANG were not the worst performers in terms of AA rates, this is not the case in AFRC – the average AA rates for every unit size above eight was markedly better. Based on these two models, there is evidence to suggest that eight TAI units struggle compared to larger units when it comes to fleet readiness, as evidenced by their lower AA rates. However, using a quadratic regression to compare evaluate AA rates against unit size may not be the best method. In the next section, the researcher will briefly discuss another method – the one-tailed t-test – and summarize the findings for AFRC and the ANG using this test.

Aircraft Availability Rate One-tailed t-test

The researcher hypothesizes that the AA rates for AFRC and ANG units with more than eight TAI will be higher than those units with 8 TAI, which is the most common unit size in the ARC. This is a statistical hypothesis, which is a statement about the numerical value of a population (fleet sizes). Specifically, the researcher's hypothesis stated above is known as the alternative hypothesis, which will only be accepted if the data provide convincing evidence that the hypothesis is true. Otherwise, in the absence of convincing evidence, the null hypothesis, which represents the status quo, will be accepted (Benson et al., 2014). In this case, the null hypothesis is that AA rates in greater than eight TAI units will not be statistically higher than those of eight TAI units. In order to determine which hypothesis to accept (and which to reject), the researcher will conduct a test statistic, which is a sample statistic, computed from data in the sample (AA rates of the different fleet sizes) that the researcher uses to decide between the null and alternative hypotheses (Benson et al., 2014).

The test statistic chosen by the researcher is known as a one-tailed t-test. A one-tailed test is a test of the hypothesis in which the alternative hypothesis is directional, and is either greater than or less than a specified value (Benson et al., 2014). In this research, the researcher is conducting a one-tailed t-test to see if the AA rates of units with more than eight TAI (the population parameter) is greater than the AA rates of eight TAI units (the specified value). From this, it is apparent why the one-tailed t-test is used, as the researcher is only testing to see if the population parameter is on "one side" of the null hypothesis value – the greater-than side. In order to determine the parameters for being able to reject the null hypothesis, the researcher established a significance level, or alpha value, prior to conducting the one-tailed t-test. The researcher chose an alpha value of .1, which equates to a confidence level of .9 or 90 percent. Another way of looking at the chosen alpha value is the probability of rejecting the null hypothesis when in fact the null hypothesis is true (Benson et al., 2014). That is, it is the probability of making a wrong decision. The higher the alpha value, the higher the confidence level, and thus the more difficult it becomes to reject the null hypothesis.

In order to reject the null hypothesis, the p-value of the statistical test must be less than the alpha value. The p-value, or observed significance level, of a statistical test is the probability of observing a value of the test statistic that is contradictory to the null hypothesis, and thus supportive of the alternative hypothesis (Benson et al., 2014). For example, with an alpha of .1, an observed p-value of .05 can be interpreted as a 95 percent (1 - .05 = .95) chance that the test statistic is contradictory to the null hypothesis. In this example, since the p-value is less than the alpha value, there is enough confidence to be able to reject the null hypothesis and to accept the alternative hypothesis.

The researcher first ran a one-tailed t-test with unequal variances on the AFRC

AA rates, with an alpha value of .1. This was performed in Microsoft Excel using the "t.test" function. The researcher tested all of the observed AA rates for each TAI size larger than eight – 12, 14, 15, and 16, respectively – against all of the observed AA rates for eight TAI units. The resulting p-values indicate the probability that the AA rates for each TAI size would be larger than the AA rates for eight TAI units while being generated from the same distribution. A p-value of .1 or less indicates 90% confidence that the observed AA rates for that fleet size contradict the null hypotheses and are statistically greater than the AA rates for 8 TAI units. The results of the AFRC one-sided t-test are displayed below:

Table 4: AFRC TAI vs AA Rate One-tailed t-test (LIMS-EV, 2019)

Probability Respective TAI AA Rates (Column) are Greater than 8 TAI AA Rates (Row)

	12 TAI	14 TAI	15 TAI	16 TAI
8 TAI	0.055253	0.017958	0.168378	0.026688

As seen in the above table, the results of the one-tailed t-test produced p-values of .1 or less for all unit sizes greater than eight TAI, with the exception 15 TAI. As a result, the researcher can confidently reject the null hypotheses, and thus state that the AA rates for AFRC KC-135 units with 12, 14, and 16 TAI will be statistically higher than the AA rates in eight PAA units. To generalize, most units with more than eight TAI will have higher AA rates, but the fact that 15 TAI units did not produce a p-value less than .1 prevent this blanket statement from being true. However, the higher p-value for 15 TAI units likely results from the fact that there were only four AA rate data points for those units, which is a small amount. Furthermore, it is worth noting that the average rates for those units was more than five percentage points higher than the average rates for eight TAI units. Even so, the one-tailed t-test provides greater confidence than the quadratic regression model for the hypothesis that KC-135 units with more than eight TAI aircraft will have higher AA rates than those units with fleet sizes of only eight, which accounted for the most data points. From this, it can be reasoned that AFRC may be hampering the readiness of its KC-135 fleet by splitting its fleet between seven units, four of which possess only eight aircraft. If AFRC were to consolidate its fleets to be at least 12 TAI in size, then the data shows that there is 90% confidence that the command will experience higher KC-135 AA rates across the board.

Next, the researcher first ran a one-tailed t-test with unequal variances on the ANG AA rates, with an alpha value of .1. This was performed in Microsoft Excel using the "t.test" function. The researcher tested all of the observed AA rates for each TAI size larger than eight – nine, ten, 12, 16, and 18, respectively – against all of the observed AA rates for eight TAI units. The resulting p-values indicate the probability that the AA rates for each TAI size would be larger than the AA rates for eight TAI units while being generated from the same distribution. A p-value of .1 or less indicates 90% confidence that the observed AA rates for that fleet size contradict the null hypotheses and are statistically greater than the AA rates for 8 TAI units. The results of the ANG one-sided t-test are displayed below:

Table 5: ANG TAI vs AA Rate One-tailed t-test (LIMS-EV, 2019)

Probability Respective TAI AA Rates (Column) are Greater than 8 TAI AA Rates (Row)

	9 TAI	10 TAI	12 TAI	16 TAI	18 TAI
8 TAI	0.073809	0.065704	0.073054	0.00072	0.404462

As seen in the above table, the results of the one-tailed t-test produced p-values of .1 or less for all unit sizes greater than eight TAI, with the exception 18 TAI. As a result, the researcher can confidently reject the null hypotheses, and thus state that the AA rates for ANG KC-135 units with nine, ten, 12, and 16 TAI will be statistically higher than the AA rates in eight PAA units. The higher p-value for 18 TAI units results from the fact that there were only three 18 TAI AA rate data points, all from Rickenbacker ANG Base from the years 2009-2011. Not only is this a small amount of data points, but the AA rates from those three years averaged out to only 62 percent, which is almost a full percentage point less than the eight TAI unit AA average across all ten years. This one-tailed t-test provides greater confidence than the quadratic regression model for the hypothesis that KC-135 units with more than eight TAI aircraft will have higher AA rates than those units with fleet sizes of only eight, which accounted for approximately 35 percent of the data points. From this, it can be reasoned that the ANG may be hampering the readiness of its KC-135 fleet by splitting its fleet between eighteen units, seven of which have a fleet size of only eight TAI. If the ANG were to consolidate its fleets to be at least 10 TAI in size, then the data shows that there is 90% confidence that the command will experience higher KC-135 AA rates across the fleet. Note that the nine TAI units are simply eight PAA units with one aircraft in BAI status, which does not affect manpower levels. Even though nine TAI units have better AA rates than eight TAI units, the researcher does not recommend nine as a unit size since it is the fiscal equivalent of an eight TAI unit as both unit sizes have eight PAA.

618 AOC Perspective

The 618 AOC, often referred to by its former name of Tanker Airlift Control Center (TACC), is AMC's execution arm. It plans, schedules, and directs a fleet of more than 1,300 mobility aircraft in support of airlift, air refueling, and aeromedical evacuation missions around the world (618 AOC, 2019). As such, the 618 AOC oversees and directs the daily operations of all AMC-owned KC-135 aircraft, to include AFRC and ANG, with the exception of the units at Eielson and Hickam. Local training sorties are not typically managed by the 618 AOC, but all other KC-135 missions that involve supporting a customer with air refueling or aeromedical evacuation are. The AMC-owned AD KC-135 units can be tasked by the 618th to support USTRANSCOM-validated requirements, but AFRC and ANG KC-135 units can only be tasked if they agree to support the tasking (618 AOC Telephone Interview, 2019). Thus, participation from the ARC in supporting non-contingency USTRANSCOM requirements can be described as being on a voluntary basis. With some 61 percent of the KC-135 fleet belonging to the ARC, this presents challenges to the 618 AOC when it comes to daily tanker availability.

As the share of KC-135s in the ARC has grown over the years, the number of tankers available for daily tasking has correspondingly diminished. Today, the 618 AOC averages only two to three AD tankers available per day for tasking, once accounting for local training and maintenance requirements for each unit along with currently filled tanker requirements. In the not too distant past, this number was even smaller until the number of KC-135s deployed to CENTCOM was reduced after it was determined that there was excess tanker capacity there (618 AOC Telephone Interview, 2019). This reality makes it very difficult for the 618th to manage USTRANSCOM-validated taskings. The effects of not having full access to the KC-135 fleet are two-fold. First, the customers with air refueling requirements are not getting the support they need, or it is provided later than their initial request. Most of the 618 AOC's customers are actually internal to the USAF, with a significant share belonging to the Combat Air Forces (CAF) community. According to one official at the 618th – "There is an insatiable appetite for air refueling, and the customers just do not understand [the aircraft availability issue]," (618 AOC Telephone Interview, 2019). The second effect is that by not having full access to iron in the ARC, the 618th too often relies on AD KC-135 units to fill these taskings, which in turn reduces their readiness. By constantly having to fill these customer requirements, the AD units must often dip into their local training fence, ground trainers, and maintenance withholds to produce the aircraft needed to make the mission happen (618 AOC Telephone Interview, 2019). This delays required home station training for operations and maintenance personnel, and also negatively affects the health of the individual fleets by reducing the amount of downtime available to perform routine and preventive maintenance actions on their aircraft.

The imbalance between AD and ARC KC-135s presents a constant challenge for the 618 AOC to be able to satisfy customer demand with aircraft availability, but that does not imply that AFRC and ANG units are unwilling to participate. As previously mentioned, the ARC units can and do regularly fill AOC taskings on a volunteer basis in a system colloquially known as “pay to play.” Under this construct, the 618 AOC receives tanker requirements and asks the various ARC units for volunteers to fill the tasking. If a unit agrees to fill the tasking, they are reimbursed by AMC with Military Personnel Appropriation funds, and thus the units are essentially paid to participate (618 AOC Telephone Interview, 2019). Despite this reimbursement, units are not always willing to participate for a variety of factors. The 618th often has difficulty getting ARC units to fill taskings that are 10 days or longer due to the challenges these units face with filling such taskings on short notice. On a typical day, six to eight ARC KC-135s are volunteered as available to fill taskings. Willingness to participate in the construct is more of a factor of individual unit personality than it is the parent component. Some ARC units are reliable and frequently called upon, while others participate more sparingly (618 AOC Telephone Interview, 2019).

Given the variability in ARC participation in support of daily operations, it is apparent that the 618 AOC frequently faces days where it simply does not possess enough available iron to fill all current taskings. When those instances arise, the taskings are rarely cancelled or unfulfilled. Instead, they are either filled at the last minute with AD tails, or the taskings are pushed to the left or the right on the calendar, where more tankers are projected to be available (618 AOC Telephone Interview, 2019). Thus, it is extremely difficult to quantify the impact the KC-135 force structure has on daily operations beyond tail availability, as most taskings are eventually filled, even if they are delayed an unsatisfactory number of times. Additionally, recent policy changes from USTRANSCOM have helped to alleviate the tanker shortage that AMC faces.

First, a General Admin message was recently released by the command, directing that CORONET missions originating in CONUS will now begin at the coastlines, and not at the home base of the unit being supported (618 AOC Telephone Interview, 2019). A CORONET mission involves long-range movement of air assets, usually fighter aircraft, in support of contingencies, rotations, and exercises by tanker aircraft (AMCI 11-208, 2017). This policy change reduces the amount of time tankers will be dedicated in support of a CORONET. Additionally, USTRANSCOM will now only validate tanker requests up to the requirement – meaning, they will not validate a request for air refueling that will place a demand above the projected tanker availability (618 AOC Telephone Interview, 2019). This will help reduce the number of times the 618 AOC is over-tasked with air refueling requests in the future.

Additional operational impacts resulting from the KC-135 force structure can be found in the size of the various units. AMC possesses the authority to mobilize gained AFRC and ANG units for mobilization in support of deployments, typically to CENTCOM (AMC/A3O). This is worked outside of the scope of the 618 AOC. When a small unit, such as an eight or nine PAA wing, is tasked for a deployment, a significant portion of their aircraft, aircrew, and maintainers are tasked as well. As a result, these small units are essentially rendered ineffective from an operational standpoint, meaning they are at approximately half strength and not considered for AOC taskings until their forces are redeployed and reconstituted (618 AOC, 2019). In larger units (12 PAA or more), the presence of more aircraft better enables them to absorb the impact of deployments, and permits them to provide support to the 618th in conjunction with ongoing deployments. With CENTCOM tanker requirements not expected to significantly diminish in the future, this continued reality exposes another weakness in the KC-135 force structure. There are 14 AMC-gained ARC units that have nine or fewer PAA. When any one of these units are tasked with a deployment, they are essentially hands-off to the 618 AOC. This further limits the options the AOC has with finding available tails to fill taskings. If the number of small units were to be reduced through consolidation, then this situation would occur far less frequently, giving the 618th more flexibility.

Two possible advantages inherent to the current KC-135 force structure are geographic air refueling coverage and alert posturing, which are interconnected. At the time of the writing of this research, 11 tanker units from all three components had aircraft dedicated to alerts ask tasked by the 618 AOC. Together, these 11 units could theoretically cover much of the CONUS airspace with their KC-135s. Reducing the number of units across the fleet could potentially make that coverage more difficult to achieve. However, of the 11 units currently filling alerts, only four of them have nine or fewer PAA. Alert posturing changes over time, thus the 11 units currently on alert will not always be in that position, but it shows that in a snapshot, the majority of alert taskings go to larger units. This may be due to the fact that larger units tend to have higher AA rates and are also better able to absorb the impact of deployment taskings, thus making them more reliable for supporting alerts. Any attempt at consolidation of the KC-135 fleet must take alert posturing into account, although the researcher believes it is possible to find room for consolidation without significantly impacting the ability to provide coverage via alerts.

One final issue within the 618 AOC's portfolio that is worth mentioning is that of Active Associations. In these associations, the AFRC or ANG unit has the lead, and the

AD unit is associated with the lead unit. Because these units are still led by one of the ARC components, they are tasked in the same manner as other ARC units, despite the presence of AD crews. The 618 AOC does not have access to the tails that belong to the lead units in Active Associations unless they are voluntarily offered up. They do, however, have access to the AD crew members and will frequently task the crews to stage elsewhere to operate another unit's aircraft. In some cases, the crews tasked from these units will be "rainbowed", meaning they are composed of both AD and either Guard or Reserve personnel (618 AOC, 2019). While there are undoubtedly benefits to Active Associations, from the perspective of the 618 AOC, they do not alleviate the issue of tanker availability, which is always in shorter supply than tanker aircrews.

To summarize the 618 AOC perspective, there are two primary force structure factors that affect the number of KC-135s available for daily tasking – the AD versus ARC mix, and the proliferation of small units. By increasing the share of KC-135s owned by AD units relative to the ARC, the number of tankers available for tasking will accordingly go up. Preventing this is the reality that there just is not much room left within the AMC AD portfolio to add more KC-135s, as addressed in the assumptions earlier in this research. As for the issue of too many small units within the ARC, consolidation would not fix the issue of AD versus ARC KC-135 mixing, but it would reduce the overall number of units, which would make those units that remain even larger in size. It is beyond the scope of this research to say for certain what would happen in such a scenario, but it is quite feasible that larger units would be more willing to participate in daily operations due to having a larger buffer when it comes to aircraft, aircrew, and maintenance capability. The presence of additional crews will also likely drive up willingness to participate in 618 AOC taskings for the purpose of building aircrew experience. Furthermore, consolidation of KC-135 units will also reduce the number of individual unit "personalities" that the 618 AOC has to contend with. This may facilitate the fostering of closer relationships, which is difficult given the 27 total KC-135 units that the AOC currently interfaces with. With fewer units in the fleet, those that remain will have to cooperate more than before with AMC to ensure continued mission success.

Fiscal Impacts

There are a multitude of different factors to consider when calculating the cost of operating a tanker wing for one year. The primary variables to consider are Operations and Maintenance (O&M) funds for the wing and its subordinate units, funds for civilian and military personnel, funds for energy and communications bills, funds for military construction, and funds for the flying hour program, among others. Given that most wings in the mobility community have very similar organizational structures, there is a certain level of overhead and staffing required in all wings, regardless of size. Larger wings will have larger staffs, but a similar number of squadrons compared to a smaller wing. Yet when considering the number of personnel per aircraft assigned to a wing, larger wings will have fewer personnel per aircraft. Consider an eight PAA wing and all the overhead required to run that wing, such as the wing staff and the four groups. If that wing were to double its fleet size, the amount of personnel it would acquire would increase incrementally instead of doubling as most of the squadrons and staff are already in place. At most, one or two additional squadrons may be created. The same would also be true for other costs, such as energy and O&M. Thus, larger wings are inherently more cost-efficient than smaller wings. It stands to reason then that the USAF should consider consolidating smaller wings to form larger wings in order to cut costs, at least within the KC-135 community.

Now is a prudent time to remind the reader that there are different methods of computing the cost to operate a wing for a single year. It is beyond the ability of the researcher to single-handedly compile and standardize cost calculations of approximately thirty wings across five different commands. As such, the researcher had to rely on figures provided by each command that was asked to provide data. In the end, AFRC and ANG programmers used different methods for providing the requested data, and thus the annual operating costs of wings as compared between the two commands varies by tens of millions of dollars. The researcher first received data from AFRC, which was pulled from the RESPLAN system, which is fed by the Automated Budget Interactive Data Environment System (ABIDES), managed by HQ USAF. This data contained the "asked for" operating budget requested by each tanker wing within AFRC, starting in 2017 and ending in 2024 (the last year with programmed funds at the time of this research). The researcher chose to use the requested budget in lieu of the executed budget as the latter can vary greatly between wings due to manpower days and unit activations, of which there are two ongoing in AFRC.

The researcher chose to focus his comparisons between the 434 ARW (16 PAA unit) out of Grissom and the 914 ARW out of Niagara (eight PAA unit), as the former has twice the number of KC-135s assigned as the latter. Additionally, the funding data that the researcher received for the other AFRC wings appeared to be incomplete. In the timeframe mentioned above, the average requested funding from the 434 ARW was $13.6M, while the average for the 914 ARW was $9.4M (AF/RE, 2019). It is no surprise that the ask from Grissom was larger than Niagara due to its larger size. However, during that time, the requested budget for the 914 ARW averaged out to be 69 percent of the total requested budget for the 434 ARW. Thus, the principle of economies of scale are displayed here, as the cost to run an eight PAA wing for one year is approximately 70 percent of the cost required to operate a 16 PAA wing. If the two differently-sized units were scaled in the same manner, then we would expect those costs to be closer to 50 percent. Assuming the annual operating costs of a 12 PAA AFRC KC-135 wing is somewhere in between the costs for eight and 16 PAA units, the below table is a visual representation of what the cost per aircraft is for each unit size (in FY19 numbers), from the perspective of annual operating budget:

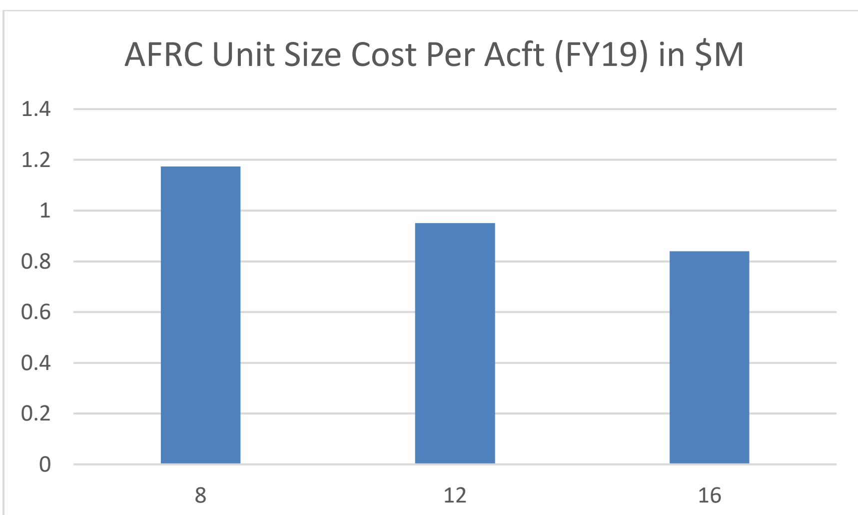


Figure 4: AFRC Cost Per Aircraft (FY19)

What this figure shows is not the actual cost to operate an AFRC KC-135, but rather how much Base Operations Support (BOS) funding (y-axis) is programmed per aircraft at each wing size (x-axis). These numbers were obtained by dividing the annual operating budget of a unit in FY19 by the number of aircraft. For example, the 914 ARW's budget in FY19 was $9.39M, and the unit had eight aircraft assigned. Dividing $9.39M by eight results in a quotient of $1.17M per aircraft in unit funding. The assumption here is that other eight TAI KC-135 units in AFRC have similar annual operating costs. This graph was created solely to visualize the inefficiencies of smaller units within AFRC - it is apparent that the cost per aircraft decreases noticeably as TAI size increases, highlighting the greater efficiencies realized in larger units.

Referencing the above data, it is apparent that within AFRC it is much more expensive to operate a large number of small tanker wings versus a smaller number of large tanker wings. For instance, assuming that the requirement to operate the 914 ARW for one year would be similar to the costs of operating another eight PAA unit, the cost to operate two eight PAA units for one year would be approximately $18.8M. Compare that to the $13.6M price tag for a 16 PAA unit like the 434 ARW, and that is a difference of $5.2M per year, which is not an insignificant amount of money over a long period of time. That equates to millions of extra dollars per year that must be spent for the same number of aircraft, and only because they are operated at more than one location when one could easily suffice.

So, what are the infrastructure savings that could potentially be realized within AFRC? The units mentioned above were used as examples by the researcher, and by no means should the unit at Niagara be singled out for consolidation. The researcher will not recommend any specific units for closure, even if certain ones appear to be better candidates than others. Since AFRC is a small command with only seven unit-equipped KC-135 bases (soon to be six with the 916 ARW converting to KC-46s), there is only room for realistically closing one KC-135 unit for consolidation purposes. The command has several options available to it. It could close one eight TAI unit, and split the aircraft between a mix of existing eight or 12 TAI units to bolster their fleets. Or it could send all eight of those aircraft to another eight TAI unit, doubling it in size, so long as there is room to expand the mission set at that location. The researcher does not have the data to make an informed, best-case basing decision for AFRC – that would have to come from the command or even a future BRAC. But if consolidation were to happen, AFRC would be able to make all but one of its KC-135 units 12 TAI or greater in size. That could result in savings up to $5.2M per year (discounting bed down costs), depending on the option chosen by AFRC.

The researcher next received data from the ANG Bureau, which was pulled from the Commander's Resource Integration System, an ANG-operated budget database. This data contained the "asked for" operating budget requested by each tanker wing within ANG, starting in FY14 and ending in FY19, although the FY19 was incomplete due to ongoing execution. The researcher chose to ignore the 127th Wing and 154th Wing financials since those units are composed of multiple MDS and the researcher was unable to break down cost categories by MDS. Additionally, those two wings had significantly higher annual costs as a result of their larger mission sets. Also of note, the 126 ARW and the 168 ARW are co-located with an active duty installation, and may have lower annual operating costs as a result. Despite this, the researcher chose to include their financials in the analysis.

Unlike the data from AFRC, the data from the ANG was consistent and complete for each KC-135 wing, thus all the wings (except for the two mentioned above) were included in the analysis. In the timeframe mentioned above, the average programmed funding for each wing size is as follows:

Table 6: ANG KC-135 Wing Operating Costs by PAA (ANG Readiness Center, 2019)

Unit Size	Average	$ Per Aircraft
8 PAA	$29,292,747.56	$3,661,593
10 PAA	$38,196,467.71	$3,819,647
12 PAA	$38,045,517.09	$3,170,460
16 PAA	$35,493,848.60	$2,218,366

Adding on to this, the below table is a visual representation of what the cost per aircraft is for each PAA unit size (x-axis), from the perspective of annual operating budget:

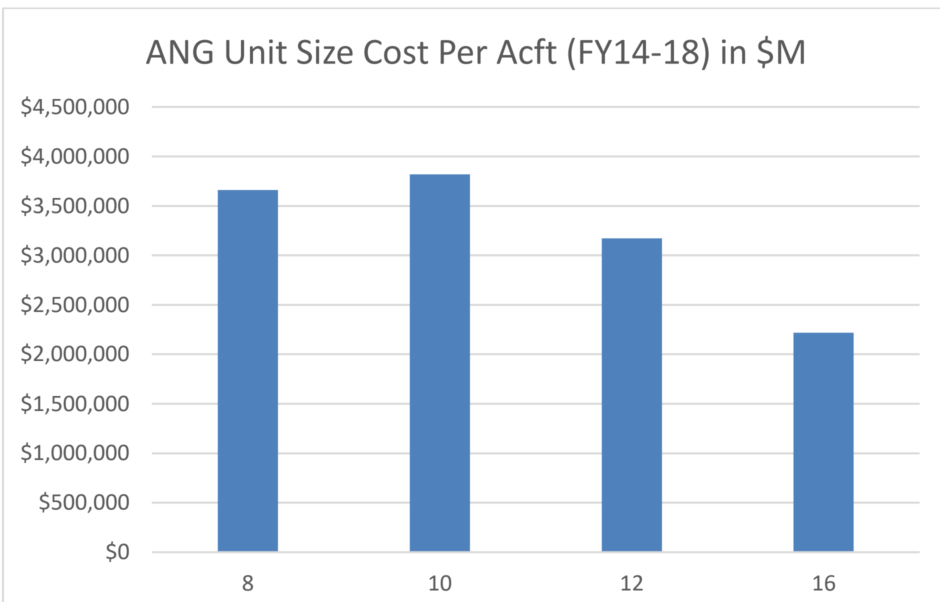


Figure 5: ANG Cost Per Aircraft (FY14-FY18)

From this data, the researcher found that 16 PAA unit sizes are the most efficient in terms of annual operating costs versus the number of aircraft, which aligns with the researcher's hypothesis, even though there was only one 16 PAA unit in the data set. What is surprising, however, is just how much more efficient the ANG's sole 16 PAA unit was than the rest – its average annual operating costs are the second lowest, and its cost per aircraft rating is almost $1M less than the second-most efficient unit size of 12 PAA. Meanwhile, ten PAA units are the least efficient in terms of annual operating costs versus number of aircraft assigned, which is surprising when compared to eight PAA units, which were the second least efficient unit size. This may be due to the small number of ten PAA units (three) compared to the ten eight PAA units included in this analysis. One of those ten PAA units, the 134 ARW at McGhee-Tyson, is also home to the I.G. Brown Training and Education Center, which conducts Professional Military Education courses for more than 4,000 service members annually and is a premier education center for the ANG ("I.G. Brown Training and Education Center," 2018). The existence of this large education center may partially explain why the 134 ARW's annual costs average about $17M/year than the other 10 PAA units.

From the data, it is evident that within the ANG, 12 and 16 PAA units are not significantly more expensive to operate than eight PAA units. For example, two 12 PAA units or three 8 PAA units would all have the same number of PAA aircraft (24). On average, a 12 PAA unit is only 30 percent more expensive to operate than an eight PAA unit, despite having 50 percent more aircraft. Two 12 PAA units would cost approximately $76.1M/year to operate. However, three 8 PAA units would cost approximately $87.8M/year to operate, a difference of $11.7M more per year compared to the two 12 PAA units.

Next, the researcher will compare eight PAA units to the more efficient 16 PAA unit size. It would take two 8 PAA units to match one 16 PAA unit in number of aircraft, yet a 16 PAA unit is only 21 percent more expensive to operate than an eight PAA unit, despite having 100 percent more aircraft. The single 16 PAA unit in the ANG costs \$35.5M/year to operate, while two eight PAA units would cost an average of \$58.8M/year to operate, for a difference of an impressive \$23.3M/year. The data is clear – it makes much more sense from a fiscal standpoint to operate a smaller number of ANG KC-135 units due to the potential savings to be realized from consolidating units to 12 or 16 PAA in size. While there is certainly an operational imperative to have air refueling coverage across CONUS via multiple operating locations, it is difficult to ignore the potential savings that could be realized from consolidation within the ANG.

So, what are the infrastructure savings that could potentially be realized within ANG? None of the units mentioned above should be singled out for consolidation – they were only mentioned to demonstrate a point. The researcher will not recommend any specific units for closure, even if certain ones appear to be better candidates than others. Compared to AFRC, there is certainly more room for consolidation within the ANG KC-135 community with its 18 operating locations. The command has several options available to it, such as closing a handful of eight PAA units, and splitting the aircraft between a mix of existing eight, ten, or 12 PAA units to bolster their fleets. Or it could send all eight aircraft from an eight PAA unit to another eight PAA unit, doubling the receiving unit in size, so long as there is room to expand the mission set at those locations. The researcher does not have the data to make an informed, best-case basing decision for the ANG – that would have to come from the command or even a future

BRAC. But if consolidation were to happen, the ANG would be able to make all but one of its KC-135 units 10 TAI or greater in size if it were to consolidate three eight PAA units with existing units. That could result in savings between $35.3M (close three eight PAA to make six 12 PAA) and $69.2M (close three eight PAA to make three 16 PAA) per year, discounting for bed down and relocation costs. While there are assumptions that factor into those figures, especially with 16 PAA options, it is clear that there are certainly avenues for realizing fiscal savings within the ANG KC-135 force structure.

Based on the above analysis, the bulk of the savings that could be realized through consolidation of the KC-135 force structure would happen in the ANG. AFRC is simply too small for a significant amount of consolidation, though it still may be worth pursuing pending further analysis. The data the researcher received on ANG KC-135 units was more robust and reliable, and better reflects reality than the data received for AFRC. The two commands use different unclassified internal systems for storing financial information and they may have applied different methods for meeting the researcher's data request, thus explaining the disparity in the data with regards to unit costs. It is therefore likely that the AFRC wing annual operating costs provided were much lower than reality, and are instead closer in size to those of the ANG units. Even so, the proportional comparison between eight PAA and 16 PAA unit costs in AFRC may still have some validity, even without knowing the true annual costs of those unit sizes.

V. Conclusions

Overarching Research Question and Summary of Research Conclusions

The purpose of this research effort was to assess the current KC-135 force structure and to identify inefficiencies that result from having 396 of these aircraft based at 31 different installations. Many of these are ARC installations that host standalone wings equipped with KC-135 fleets numbering only eight or nine total aircraft. This first required analysis of how the USAF arrived at the current KC-135 force structure. The researcher discovered that most KC-135 units have been in existence since the major reorganization associated with the end of the Cold War, with some dating as far back as the days of SAC, and that only a few units have been established in the last two decades. The proliferation of the KC-135 fleet was largely driven by mission requirements and a fundamental restructuring within the USAF, but very little has been done to consolidate the fleet since the major upheaval in the early 1990s.

Next, the researcher analyzed the operational impacts of the current force structure and found that within both AFRC and the ANG, having a larger number of small units (e.g. eight aircraft) is negatively impacting KC-135 AA rates. The researcher was able to prove that KC-135 units that are equipped with more than eight aircraft have statistically higher AA rates than units with only eight aircraft. This means that such units, generally, will have more aircraft available for operational taskings and drive higher tanker readiness rates across the USAF, facilitating the fulfillment of national military objectives. Furthermore, the researcher found that the 618 AOC is constrained by the reality of having the majority of the KC-135 fleet in the ARC, as those aircraft are not always available for tasking to meet USTRANSCOM-validated mission takings. Furthermore, because many of these units in the ARC are so small, the 618 AOC is unable to turn to them for help when said units are already supporting a deployment or other off-station tasking. If these units possessed more aircraft, then they would be better equipped to support higher headquarters taskings in combination with other events.

Finally, the researcher analyzed the fiscal impacts of the current KC-135 force structure and discovered that operating a large number of smaller wings is far less efficient than operating a small number or larger wings within both AFRC and the ANG. In both commands, millions of dollars per year could be saved in infrastructure and BOS costs if smaller eight PAA units were consolidated with each other to create larger-sized units - either 12 or 16 PAA in size. Within AFRC, there is likely only room to close one eight PAA unit due to the small number of KC-135 bases. Within the ANG, it is feasible to stand-down up to at least three of the eight PAA units due to the larger KC-135 community within that command. In both situations, consolidation of the recommended number of units described above would leave only one each eight PAA unit remaining in each command. Further analysis from those commands could likely produce a course of action that would result in no eight PAA units remaining post-consolidation.

Recommendations

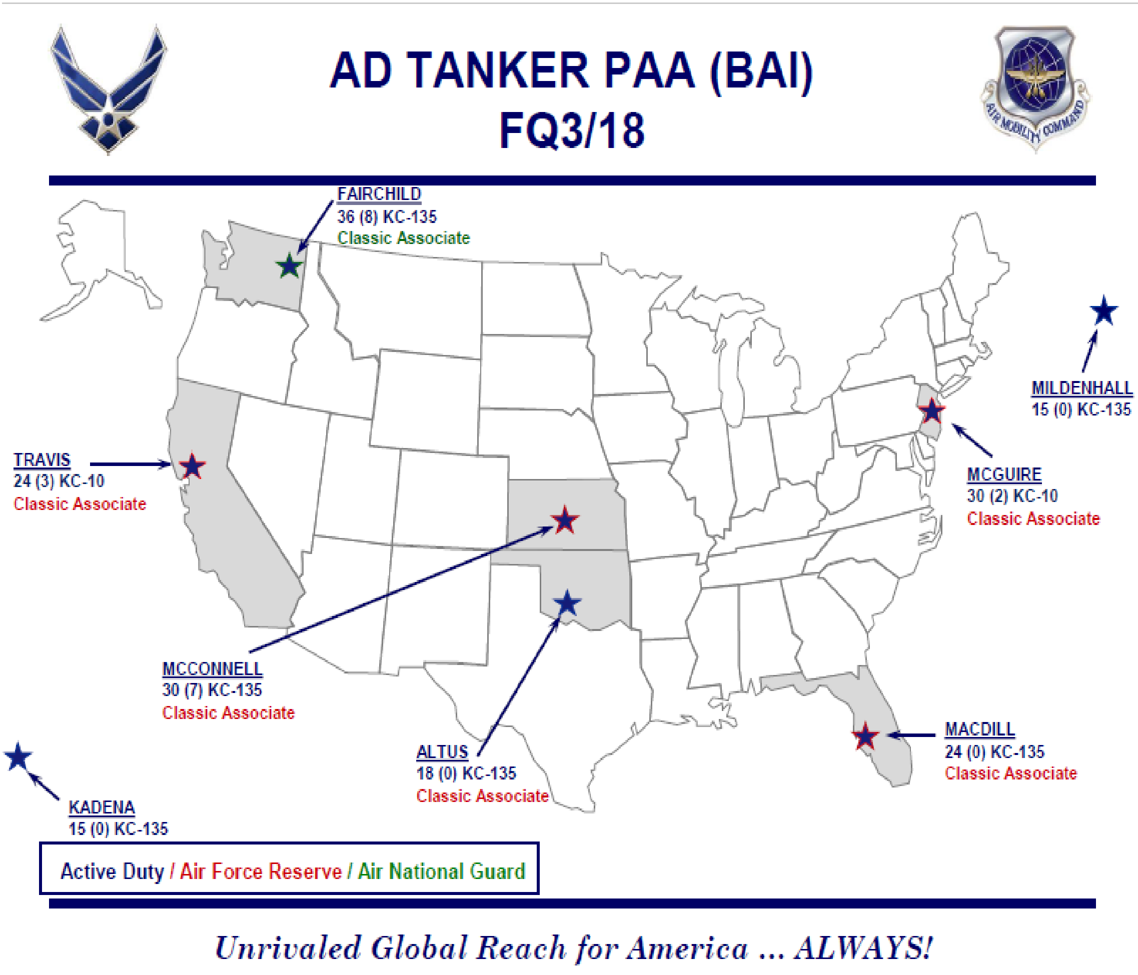
Generally, the quantitative analysis of the KC-135 force structure provided strong support for unit consolidation within the KC-135 force structure to address existing operational and fiscal inefficiencies. The researcher has shown exactly how the current basing construct negatively impacts AA rates while costing excess money, but the power to change that reality largely rests with Congress. The researcher strongly recommends that Congress convene another BRAC round and that the members of the commission consider the findings of this research while conducting their analysis. The findings and recommendations of a future BRAC are the only realistic option for forcing a restructuring of the KC-135 fleet for the purpose of increasing readiness and decreasing annual operating expenses.

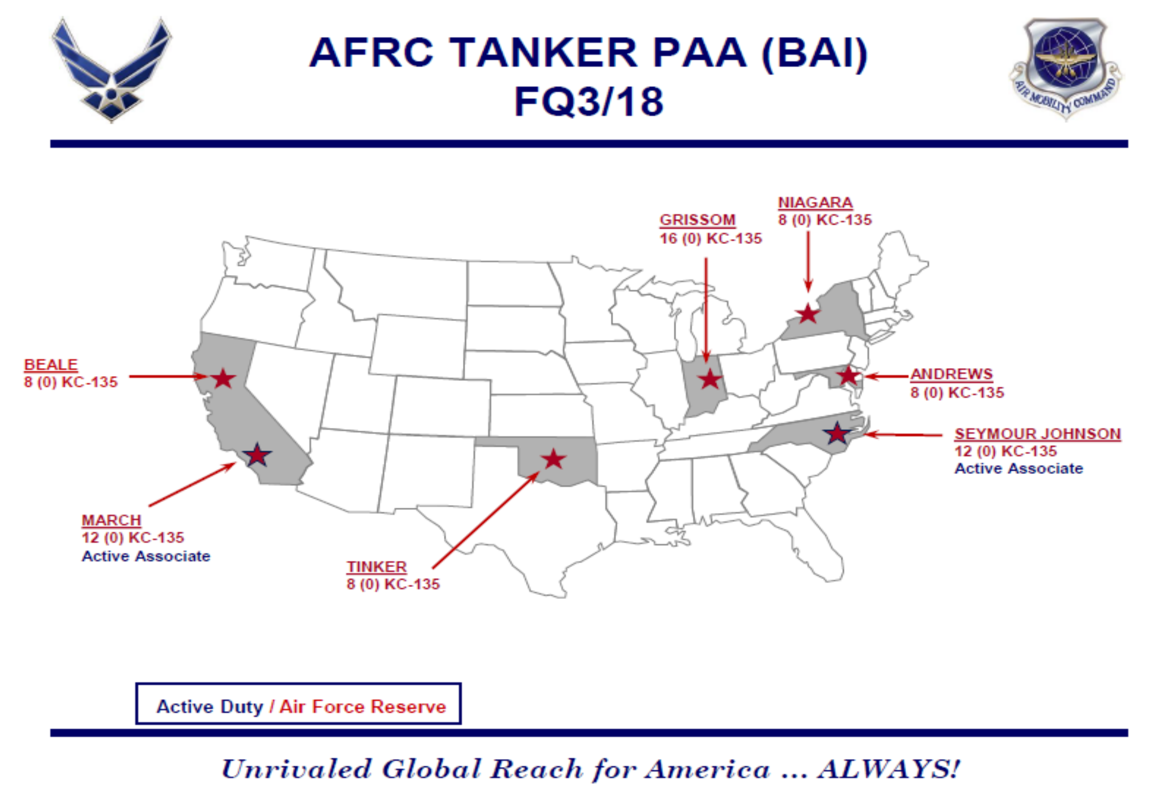
Future Research Considerations

Although some quantitative analysis of the cost of ARC KC-135 wings was conducted by the researcher, it was limited in scope due to the researcher's reliance on third parties for the data and the limited time to compile that data. Only the respective programmers within AFRC and ANG that oversee the tanker portfolios possess both access to the required systems and the knowledge of the individual units and program elements to be able to conduct a thorough compilation and comparison of the line by line costs of each KC-135 wing. Undoubtedly, there were cost accounts that were overlooked when data was provided to the researcher. Such an effort would likely require a team of individuals to complete over several full days of work. Since this undertaking would require constant access to the Secret Internet Protocol Router Network and other systems not readily available outside of headquarters, the researcher recommends that further research in this area be conducted internally by both AFRC and ANG programmers, if not first mandated by the Headquarters USAF corporate structure. This is not a task suited for an individual researcher due to the complexity of the data and the special access needed to acquire it. Further research with a greater team size and a mandate to complete will produce a clearer picture of ARC wing operating costs and how consolidation might best be achieved. In the event a future BRAC round is convened, having this research already completed would be of benefit.

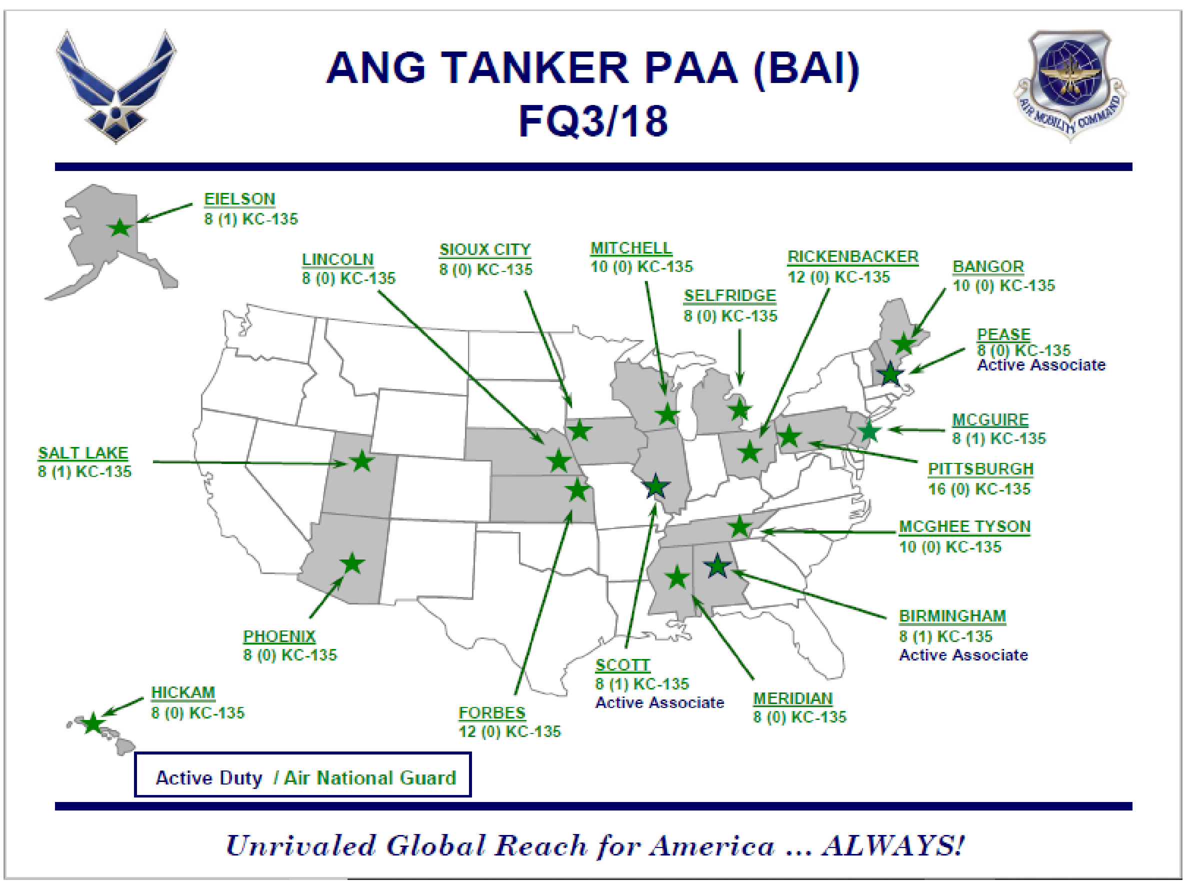
Appendix A

Current Tanker Force Structure Maps





AFRC TANKER PAA (BAI)
FQ3/18
GRISSOM
16 (0) KC-135
NIAGARA
8 (0) KC-135
BEALE
8 (0) KC-135
ANDREWS
8 (0) KC-135
SEYMOUR JOHNSON
12 (0) KC-135
Active Associate
MARCH
12 (0) KC-135
Active Associate
TINKER
8 (0) KC-135
Active Duty / Air Force Reserve
Unrivaled Global Reach for America ... ALWAYS!



ANG TANKER PAA (BAI)
FQ3/18
EIELSON
8 (1) KC-135
LINCOLN
8 (0) KC-135
SIOUX CITY
8 (0) KC-135
MITCHELL
10 (0) KC-135
RICKENBACKER
12 (0) KC-135
BANGOR
10 (0) KC-135
SELFRIDGE
8 (0) KC-135
PEASE
8 (0) KC-135
Active Associate
MCGUIRE
8 (1) KC-135
SALT LAKE
8 (1) KC-135
PITTSBURGH
16 (0) KC-135
MCGHEE TYSON
10 (0) KC-135
BIRMINGHAM
8 (1) KC-135
Active Associate
PHOENIX
8 (0) KC-135
SCOTT
8 (1) KC-135
Active Associate
HICKAM
8 (0) KC-135
MERIDIAN
8 (0) KC-135
FORBES
12 (0) KC-135
Active Duty / Air National Guard
Unrivaled Global Reach for America ... ALWAYS!

Appendix B

AA Rate Data Points

AFRC AA Rate Data Points by TAI (FY09-FY18)

8	12	14	15	16
64.19	68.11	73.96	77.39	72.5
73.51	73.85	64.05	73.9	69.2
56.28	68.16	74.14	58.14	76.4
70.47	70.2	68.29	65.69	70.4
67.83	78.84	78.02		75.6
64.13	77.72			78
73.75	56.47			78
67.89	62.94			74.3
65.37	66.53			74.9
64.28				67.8
50.01				59.33
55.58				64.16
33.63				67.16
55.71				77.65
67.99				65.77
60.66				60.53
76.11				52.74
75.93				

ANG AA Rate Data Points by TAI (FY09-FY18)

8	8	9	9	10	12	16	18
68.78	72.83	50.34	67.61	43.91	63.42	74.95	56.4
46.51	66.94	44.96	54.54	56.58	57.78	67.93	62.32
73.45	59.28	66.05	58.47	68.61	72.37	68.32	67.33
66.16	65.85	63.43	51.73	67.37	72.34	73.01	
68.31	62.46	67.66	69.16	56.63	71.51	73.22	
65.46	72.88	65.73	71.55	58.91	63.65	73.42	
65.65	66.19	54.28	73.7	62.13	65.16	69.11	
67.48	75.13	64.1	78.03	54.42	62.29	63.76	
61.31	53.83	54.66	76.98	57.52	64.05	63.1	
67.28	55.41	66.18	74.06	66.45	61.41	59.68	
58.59	43.29	62.71	72.08	67.44	61.28	77.64	
71.11	50.74	70.89	77.57	58.89	74.5	75.83	
67.31	68.25	69.33	67.17	62.67	72.38		
71.49	69.66	59.71	60.37	61.25	58		
61.71	59.68	72.36	63.7	59.55	72.51		
69.61	65.87	64.74	62.87	59.15	66.52		
67.35	47.7	64.16	73.14	61.99	62		
64.67	49.69	58.82	75.58	58.46	65.28		
68.7	39.81	54.91	63.61	64.27	57.49		
60.03	72.74	67.92	67.63		67.96		
64.5	59.26	61.44	64.62		67.92		
66.71	53.55	53.12	83.7		66.95		
58.21	69.59	57.26	79.1		68.43		
58.8	69.63	66.42	63.27		61.2		
44.22	68.04				58.97		
61.63	66.78				57.11		
62.02	68.57						
66.65	61.86						
61.21	58.48						

Appendix C

KC-135 Force Structure Quad Chart

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
14-06-2019	Graduate Research Paper	*Jun 2018 - Jun 2019*

4. TITLE AND SUBTITLE

KC-135 FORCE STRUCTURE: IDENTIFYING OPERATIONAL AND FISCAL INEFFICIENCIES

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Ratcliffe, Matthew T, Maj , USAF

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Air Force Institute of Technology
Graduate School of Engineering and Management
(AFIT/EN)
2950 Hobson Way
WPAFB, OH 45433-7765

8. PERFORMING ORGANIZATION REPORT NUMBER

AFIT-ENS-MS-19-J-044

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

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10. SPONSOR/MONITOR'S ACRONYM(S)

AMC/IG

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Distribution Statement A. Approved for Public Release. Distribution unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The KC-135 Stratotanker is one of the most numerous and widespread aircraft in the Air Force's fleet. With 396 aircraft located at 31 different installations, a massive amount of infrastructure is dedicated to supporting the airframe. This research proposes that there are too many operating locations in the KC-135 force structure, which is a result of the numerous small unit sizes operating in the Air Force Reserve and Air National Guard components. The researcher hypothesizes that the current state of the KC-135 force structure is having a negative impact on the airframe's operational readiness rates while also costing the Air Force money due to inefficient unit sizes. The researcher uses a qualitative analysis to detail the history of the KC-135 force structure and to describe how the current force structure impacts daily operations. Following this, the researcher demonstrates that larger KC-135 units have statistically higher aircraft availability rates than smaller units. Finally, the researcher uses quantitative analysis to show that larger KC-135 units are more economically efficient than smaller units. This research paper recommends the consolidation of existing KC-135 units in the Air Reserve Component. This would increase unit fleet sizes for the purposes of improving aircraft availability rates while also saving money on infrastructure and overhead costs. The researcher recognizes that closing units for consolidation is a politically sensitive issue, and thus does not recommend any specific units for closure. Instead, the researcher recommends that Congress convene a future Base Realignment and Closure round and use the findings from this research to propose a more efficient force structure for the KC-135.

15. SUBJECT TERMS

KC-135, Force Structure, Aircraft Availability

16. SECURITY CLASSIFICATION OF: Unclassified			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
					Dr. Jeffery D. Weir, AFIT/ENS
a. REPORT	b. ABSTRACT	c. THIS PAGE	UU	93	19b. TELEPHONE NUMBER *(include area code)*
U	U	U			(937) 255-3636 Ext 4523

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18