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**FOREFLIGHT TECHNOLOGY AND THE 60-YEAR-OLD TANKER:
IMPROVING KC-135 OPERATIONS WITH THE IPAD**

by

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ABSTRACT

Available iPads along with planning applications can greatly enhance KC-135 operations. New technologies are being integrated into every aspect of life, personal and professional. The iPad along with applications used on this device have been leading the way in this technological frontier. The ForeFlight application is a versatile aviation planning and execution tool utilized by many general aviation, commercial airlines and military flying units. The KC-135 community is using the iPad for accessing publications, but not as a planning or execution tool. The research explored the following question: “Would the utilization of the ForeFlight application on the iPad produce positive effects for KC-135 operations?” The methodology used for this research was the evaluation method with the criteria being efficiency, safety and flexibility. The key findings were that the ForeFlight application would bring efficiency, safety and flexibility to KC-135 operations. Efficiency will be realized in reduced fuel usage and time savings. Safety is seen in increased situational awareness and reduced risk from developing weather phenomena. Flexibility is effected in ability to reroute and change the mission. These criteria were found to have value in the security, mission planning and mission execution phases of tanker operations. Changes to procedures for the Communications Flight, mission planners in Tactics Flight and aircrew members are required to implement the use of ForeFlight. These changes require updates to key publications including AFI 11-2KC-135V3, AFI 11-2KC-135V3 128 ARWSUP1, KC-135R/T In-Flight Guide, 128 OG OI 11-1, Tactics Daily Checklist and Mission Planning Checklist.

Introduction

Technology is rapidly changing every aspect of life. Integration of these technologies is taking place from smart phones and watches to home thermostat systems that can be remotely accessed. The iPad was at the leading edge of this technology explosion and has gone from a novel item to own to an essential electronic device. The iPad has become an indispensable tool in all facets of life, social and professional, owing in large part to its portability and versatility.

The iPad in conjunction with planning apps such as ForeFlight has provided efficiency, safety and flexibility in the commercial aviation industry over the past few years. The civilian industry utilizes such features as flight planning, weather analysis, Automatic Dependent Surveillance-Broadcast (ADS-B), electronic flight bag (EFB), scheduling and log books. This has revolutionized operations for airline pilots, providing them with a much greater level of situational awareness. Although this has provided benefits for the civilian aviation industry, the military has not integrated this technology into standard operations. There are some military units that have fully integrated the technology while others have not. No standard has been set. At the 128th Air Refueling Wing (ARW) and the tanker community as a whole the iPad is utilized as an EFB only. This is minimal use of a highly capable device that is already paid for and available.

This research explores the following question: “Would the utilization of the ForeFlight application on the iPad produce positive effects for KC-135 operations?” This research used operations at the 128 ARW as an example for operations across the KC-135 fleet. This research maintains that tanker operations would realize positive effects from the utilization of the ForeFlight application on the iPad.

This research utilized an evaluation methodology to answer the research question. This evaluation has carefully examined and appraised the possibility of positive effects from the

utilization of the ForeFlight application on the iPad for KC-135 operations at the 128 ARW and across the entire KC-135 fleet. This evaluation has resulted in recommendations for implementation of the ForeFlight application on the iPad given the evaluation criteria.

This introduction is followed by the background section. A thorough literature review of sources covering general aviation, commercial airline, military aviation and security topics are covered. The technologies of the ForeFlight application and iPad have been integrated into general aviation, commercial airline and certain military daily operations to increase efficiency, safety and flexibility.

These factors, efficiency, safety, and flexibility, are the basis for the criteria analyzed for KC-135 operations at the 128 ARW to show how these areas may be maximized by the use of ForeFlight on the iPad. Each criterion was evaluated with equal weight.

The results of the evaluation were discussed, both positive and negative in each category. Conclusions were then made based on the analysis of the results. These results and conclusions were then analyzed to provide recommendations.

The research has illuminated the multiple capabilities of this application available to pilots and planners of the tanker community. The information has built upon the established information from the civilian and military community which has integrated the iPad and planning tools into daily operations. These capabilities have been analyzed to fit within the spectrum of tools already used in the planning and execution process to produce positive effects for KC-135 operations. This will be accomplished by synthesizing the current resources available and developing a framework for utilization that makes sense for the mission planning and execution of KC-135 operations.

The results of this research will be applied to the KC-135 fleet by changes to the mission planning and execution process. This will include changes to the AFI 11-2KC-135V3. This will

also include changes to local procedures. The 128 ARW will be used as an example for these local procedures, including the Inflight Guide for aircrews and the 128 ARW OGI 11-1. The Tactics Flight performs the mission planning function at the 128 ARW. Products from this shop are provided to aircrew to enable them to execute the mission. The Tactics daily checklist spells out processes required to be performed to provide these mission planning products to the aircrew. The Inflight Guide is a tool used by the aircrew during mission planning and execution. It contains pertinent information in an easy to reference place, such as routing in the local area, commonly used frequencies, and how to accomplish practice emergency checklists. The 128 ARW OGI 11-1 is a locally generated instruction outlining the planning process from a safety perspective. Updating these documents will benefit the Airmen in Operations, the 128 ARW, the KC-135 community, and ultimately see savings for the U.S. government.

As an overview, the report includes a Background, Methodology/Explanation of Evaluation Criteria, Analysis of Results, Conclusions, and Recommendations.

Background

The use of ForeFlight on the iPad for tanker operations was researched for many reasons. The iPad is already being utilized as an EFB that has proven to save money for the unit and all tankers by saving the cost of physical paper and requiring less weight in support materials on the aircraft which translates into reduced fuel consumption. The usage of the device in this capacity has been successful and has been implemented into the daily operations across the tanker fleet and at the 128 ARW. The capability of this available platform is not being used to its full potential at the 128 ARW or other tanker units from the active Air Force, Guard or Reserves. This is a waste of available resources that could be benefiting operations by increasing efficiency, safety and flexibility across the entire KC-135 fleet.

ForeFlight

The use of ForeFlight specifically on the iPad was analyzed in this research over other applications for a few reasons. It has a wide range of available features such as EFB capabilities, flight planning and flight log, route optimization, moving map, ADS-B traffic following, weather forecasts and inflight interactive weather. Reference Figure 1 for a general display of the ForeFlight application on the iPad. This shows the chart view with the route of flight for the aircraft with the weather overlaid over the chart. The Air Force has already approved this application for use on the iPad so there is no need to go through the approval process, saving time and resources for duplicate efforts. Specific MAJCOMs (Major Commands) have embraced its use such as AFSOC (Air Force Special Operations Command). There exists contemporary data from within the civilian community, from industry manuals that are prevalent and useful in providing a foundational framework of knowledge in this realm. The “Pilot’s Guide to ForeFlight Mobile” covers all of the application’s capabilities and available functions.¹ This application is the most popular iPad application available for pilots. “With a nice balance of powerful features, an easy-to-use interface and strong customer support, it’s an ideal app for both professional pilots and weekend warriors alike.”²

There are other areas of aviation where this technology is utilized including general aviation, commercial airline and even certain military units. General aviation pilots have been using ForeFlight to increase safety and situational awareness. Airlines, such as United, have invested in the technology successfully to increase safety and efficiency for their businesses. There are also some military units that have integrated the iPad with ForeFlight into their operating procedures with much success. The ForeFlight app is compatible with the iPad and is available for military use. This is a widely used application with a vast number of capabilities to consider. With the tightening of fiscal military budgets, it is important to find innovative ways to save money, time and increase safety.

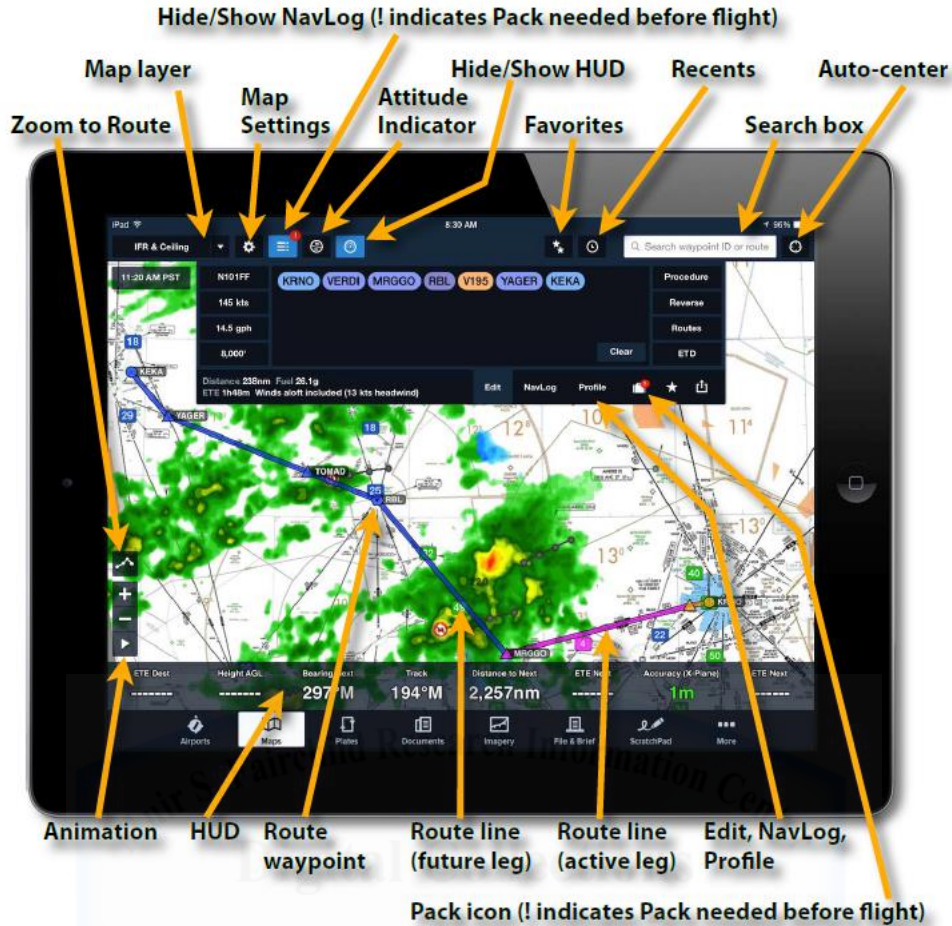


Figure 1³- ForeFlight Application on iPad featuring route of flight with weather overlay

General Aviation

General aviation pilots have embraced this new technology. There are articles illuminating the advantages that civilians have been able to realize with the use of this technology. Private pilots are flying smaller aircraft for recreational purposes. Their level of training and experience is less than what is required by professional pilots. These pilots need versatile tools to help in their recreational flying. General aviation utilizes these applications extensively, increasing their level of safety in aircraft with less automation and capabilities. The iPad is able to bring a level of technology to the general aviation cockpit that is very expensive to buy as permanent equipment to the aircraft. “Tablets and the apps they run are making general

aviation safer, less expensive and more vibrant... (They) have access to every aviation chart, IFR or VFR, for the entire country, and they can be updated in a matter of minutes. That's good for safety.”⁴ The information displayed on these devices shows general aviation pilots a larger picture of where they are in the airspace and the factors affecting their flight. This increases situational awareness and safety.

Commercial Airline

The airline industry has taken advantage of this technology. Saving money for the company and shareholders is extremely important for commercial companies. The value of the iPad as a tool has been realized in all criteria areas: efficiency, safety and flexibility. United Airlines touts the value in the utilization of this type of technology. “Having the best technology allows you to make the best decisions to fly efficiently and arrive safely. If you have an accurate display like iPad on board, you’re able to plan a better route”⁵ Airline pilots are able to use the technology for all aspects of their work. Weather is studied before showing up at the terminal to fly. The application allows the pilots to run performance information for the route of flight. The GPS and airfield diagram display the aircraft as it taxis around unfamiliar airfields. The altitude may be varied along the route of flight to allow for a smoother flight and take advantage of more favorable winds. All instrument approaches and airfield diagrams are available on the device no matter what airfield the aircraft is bound to go. After the flight, pilots may use the application to log their flight time.

Military Aviation

The military does have some guidance on the use of the iPad, but a standard operating procedure (SOP) has not been developed and integration has been inconsistent. Some MAJCOMs have implemented the use of ForeFlight while others have not. Current Air Force

regulations allow for the use of personal electronic devices (PEDs) “used to facilitate operation of the aircraft.”⁶ This has mainly been realized as use as an EFB.

Centralized control with decentralized execution is an important tenet discussed by AMC (Air Mobility Command). Planners and aircrew need to have the best and most current information available to be able to carry out this tenet. “The value of air mobility forces lies in their ability to exploit and enhance the speed, range, flexibility, and versatility inherent in air power... decentralized execution fosters initiative, situational responsiveness, and tactical flexibility.”⁷ Air power is maximized when Airmen at the operational and strategic levels are able to make the best decisions with available technology.

Planning is of paramount importance in the AMC planning vision. “Air mobility operations, whether performed in war, contingencies, or peacetime efforts, rely on good planning to be effective and efficient... As these various planning tasks are conducted, the air mobility planner must consider a variety of impacts on intended operations, from availability of basing and resources, to execution challenges like weather, threats, and force protection.”⁸ The iPad and ForeFlight application would be versatile planning tools based on the principles of maximizing resources and technology to create solid plans efficiently to accomplish the tanker mission.

The ForeFlight application is an Air Force approved application to have on the iPad, but has not been utilized in the tanker community or at the 128 ARW. The 128th Air Refueling Wing 128 OG OI 11-1 addresses the mission planning process for the unit. This document has a section that discusses the programs utilized currently to mission plan with a focus on safety management.

There are certain airframes in the Air Force that have embraced the use of the iPad with ForeFlight. This application has been downloaded onto over 11,000 DoD devices as of January

2017.⁹ These include many of the Air Force white jets as well as bombers such as the B-52 and B-1B. The Standards and Evaluations (Stand Eval) shop from the 150 SOS (Special Operations Squadron) at Joint Base McGuire provided information and source material in the course of research. The 150 SOS flies C-32B for Air Force Special Operations Command (AFSOC). The 150 SOS has fully embraced the iPad. Operations are completely paperless and the aircraft were modified with Tablet Interface Modules (UTC Aerospace Systems) to allow the iPad to be plugged into a USB port for charging and enabling the iPad to find and display aircraft position en route.¹⁰ The ForeFlight application is being utilized to increase efficiency, safety and flexibility in all operations from local training sorties to deployments.

Security

Cyber security is a new frontier that needs to be considered when utilizing emerging technology. The security of the system is an obstacle to be overcome because of the use of internet and Wi-Fi in conjunction with the iPad. The iPad is updated and receives information via a Wi-Fi connection. The device could fail or display inaccurate information if corrupted data is received through the Wi-Fi connection. Better cyber security measures are being implemented as this issue increases across all military domains. General aviation and the commercial airlines have had to struggle with this problem as well.

Security is the main vulnerability when using the iPad with the ForeFlight application. Utilizing Wi-Fi inflight does bring a level of risk that needs to be considered. “The seeds of doubt, combined with the estimate that 24,000 airliners will have cabin and likely cockpit inflight connectivity by 2024 (up from 6,800 connected aircraft last year), have governments and the aviation industry scrambling to find and fix any cybersecurity holes and hacking vulnerabilities.”¹¹ This weakness must be addressed and mitigated. Aggressive steps are being taken to combat this threat from both the civilian and governmental agencies.

Regulations are in place to address this issue. The FAA has established guidelines for use in the aviation industry to mitigate this threat. “All EFBs using data connectivity provisions to aircraft systems must incorporate an interface protection device (e.g., physical partitioning, read-only access, etc.) to ensure data connection required by the device, and its software applications, have no adverse effects on other aircraft systems, including installed antennas, installed data servers, data storage devices, and memory.”¹² This suggested precaution hardens the device to hacking at the interface point between the Wi-Fi connection and the iPad. The device could fail, but the aircraft would remain on its flight path and operations continued without the use of the iPad.

The advantage for the KC-135 community is that the system is autonomous, not integrating directly into any part of the actual KC-135 system. This means that the aircraft systems would not be impeded by the limitations of those posed by traditional iPad uses. The device could fail, but the aircraft would remain on its flight path and operations continued without the use of the iPad. The threat of a hack into the iPad does not threaten the KC-135 directly like it would an airline because the iPad is not accessing any capabilities directly into the KC-135 system, but data utilized on the iPad that is corrupted or compromised may be a concern.

Methodology/Explanation of Evaluation Criteria

The research conducted utilized three evaluation criteria to examine the possible benefits of integrating the use of ForeFlight into tanker operations across the fleet by using the 128 ARW as an example. These criteria were chosen based on the Operations Group Focus Areas for the 128 ARW.¹³ These areas provide Airmen of the Operations Group with a few areas to focus on as they go about their daily activities to support and execute the tanker mission. Supporting the

missions of global power and nuclear deterrence, exercising good stewardship of resources, and protecting personnel and equipment are important for the Airmen of the 128 ARW.

The KC-135 mission supports aerial refueling as well as transport of personnel and cargo. The aerial refueling mission extends the reach of the U.S. military by keeping airborne assets such as fighters and bombers in the air and eliminates the need for cargo aircraft to stop along their route. The 128 ARW supports both Air National Guard and Air Force tasking locally and globally. Whether flying local training sorties to maintain currency or deployed globally for contingency operations, efficiency, safety and flexibility are requirements of the mission. These three criteria provided a good standard to measure the effectiveness of the iPad with ForeFlight application to create positive effects for the KC-135 operations at the 128 ARW and across the KC-135 fleet.

Efficiency

Efficiency is very important in the current time of fiscal constraint. Every area of the U.S. Government needs to be good stewards of tax payer dollars and cut costs when possible. All resources must be utilized in a thoughtful manner to not only accomplish the mission, but find savings when available. Innovation and new technologies are key areas to find new efficiencies.

The KC-135 refueling mission is an AMC responsibility. AMC is the largest consumer of fuel in the Air Force and as such, there is an emphasis on efficiency whenever the mission allows. “The Secretary of the Air Force has set a goal of 10% improvement in aviation fuel efficiency by 2020.”¹⁴ When fuel savings can be realized by an AMC asset, this saves the Air Force and U.S. government a tremendous amount of money. This metric was used to analyze the ability of the ForeFlight application to provide information to find efficiencies in routing and time savings.

Safety

Safety is an important factor when planning and executing aviation missions. Personnel are the most valuable asset for the Air Force. The time and training put towards each crewmember is very costly and each crewmember is not easy to replace. In 2013 it cost tax payers about \$6 million to train an Air Force pilot.¹⁵ AMC is currently facing a pilot shortage that emphasizes the need to protect this valuable resource. The cost of a KC-135 aircraft is \$39.6 million.¹⁶ It is crucial to protect personnel and equipment by mitigating or eliminating risks that could endanger the aircraft or crew.

Risks are encountered at every step of the mission planning and execution process. “Risk is inherent in all missions, operations and activities, both on- and off-duty. Risk can be effectively mitigated if understood and appropriate action is taken.”¹⁷ Finding new tools to help mitigate and eliminate risks increases safety. This safety metric analyzed the effectiveness of ForeFlight’s capability to forecast risks to be mitigated as well as providing improved situational awareness for aircrews to mitigate risk.

Flexibility

Flexibility remains the key to airpower. There is a motto that every tanker pilot is proud to proclaim, “Nobody kicks ass, without tanker gas!” The KC-135 has a customer service mission and is required to be there for the receiver so that they are able to complete their mission. Without the refueling, receiver aircraft have to divert to alternate locations or cannot make it to their target area. Being able to meet these needs requires flexibility in timing and possibly altering flight paths to complete an inflight refueling. It is a dynamic mission that changes with the needs of the receiver.

The aviation environment also requires flexibility. Meteorological conditions do not always remain the same as what was in the forecast. Tanker missions vary in length from a few

hours to as many as thirteen. Having current information provided during the entire flight gives flexibility to the aircrews in decision making. This flexibility metric analyzed the ability of the ForeFlight application to meet the changing needs of the tanker mission.

Analysis of Results

The analysis of this research found that there are many benefits that the ForeFlight application on the iPad could bring to tanker operations at the 128 ARW and across the tanker fleet. This analysis has provided a description of the results from each criteria; efficiency, safety, and flexibility.

ForeFlight Efficiency

Efficiency is a very important emphasis area for the Air Force at this time. Secretary of the Air Force Deborah Lee James and Air Force Chief of Staff Gen. David L. Goldfein stressed the importance of efficiency in a memorandum sent to Airmen across the Air Force. James and Goldfein stated in the memorandum, “As we evolve our Make Every Dollar Count campaign, we will stay the course with the culture of increased productivity and efficiency while weaving in a stronger emphasis on ‘Airmen’s time’ and increased effectiveness.”¹⁸ Streamlining activities for Airmen so they are able to utilize their time most efficiently saves the government money. The iPad is able to capitalize on this area by having all information on one device for the aircrew. The ForeFlight application is specifically designed to maximize efficiency; from flight plan, charts, and weather, everything is available in one location for quick and easy access.¹⁹

Fuel efficiency is the main metric that the tanker community uses to determine efficiency of operations. The ability to save fuel costs brings large savings in a very quick timeframe due to the number of tankers in the inventory. The standard price for Jet A fuel, effective 01 April 2016 was \$1.86 per gallon.²⁰ The tanker holds roughly 33,000 gallons of fuel. That means that when the tanks are full, there is \$61,380 worth of fuel aboard one tanker. There are 391 KC-135

aircraft in the U.S. inventory.²¹ Fueling the fleet with one tank of Jet A each costs \$23,999,580. The ability to use this fuel for maximum return across the whole tanker fleet makes a big difference for the overall savings to the U.S. government. Even the ability to drop that price by .5% would bring a savings of \$119,997.90 for each tank up of the fleet. The application has this capability.

The ForeFlight application provides efficiencies besides its ability to show all planning materials in one spot. The application is able to find efficiencies in the route of flight. “ForeFlight Performance comes bundled with a web interface component as well, for more convenience in route and fuel preplanning while at home station. This interface is capable of syncing flight, fuel, and route plans directly to the crews’ mobile devices where security policy allows.”²² When planning and executing the mission the winds may be analyzed to find the most efficient cruise altitudes for the specific route of flight and fuel load. The ability to fly the aircraft with a 10 knot headwind compared to a 100 knot headwind saves time and fuel. That brings the cost down.

The winds along the route are not static and may vary from the mission planning phase. Currently the tanker community relies on radio communication between air traffic control (ATC) and other aircraft in the area to find out if winds may be more favorable at varying altitudes. Even this information is just a guide because it doesn’t take into account the aircraft’s actual route or performance capabilities. “The Altitude button displays the Altitude Advisor™ which shows the modeled winds aloft at various altitudes, provided the required route and performance data are available. Altitudes resulting in a net average tailwind over the route are shown in green, while those resulting in a net average headwind are shown in red.”²³ This gives a quick, easy to read guide to maximize winds during the flight to save time and fuel.

The ForeFlight application provides accurate information for the exact route of flight by taking into account the specific aircraft performance. “Accounting for real-world constraints including the fuel capacity of specific aircraft and their maximum take-off and landing weights, ForeFlight Performance also advises efficient operating altitudes to maximize fuel savings, which can total to thousands of dollars per trip, or can (be) used to extend range or increase useful load.”²⁴

The ForeFlight application does not come without costs. Although the iPad is already provided to the tanker community and the ForeFlight application is approved for use, the application is not free. The ForeFlight Company charges an annual fee for the service and in return, makes sure that the application is updated and contains all the most current databases. The annual fee per license is \$280 per year.²⁵ The license is good for one iPad, so each iPad that ForeFlight is installed on at a tanker unit would cost \$280 a year to maintain. At the 150 SOS each pilot has their own iPad with ForeFlight installed. At the 128 ARW there are roughly 50 pilots and 25 boom operators. That would cost the unit \$21,000 per year to license every iPad.

There are a few ways to minimize this cost. Another technique is to license a given number of iPads for use at the unit to go with each aircraft. For the 128 ARW this would mean licensing 20 iPads for use with the ForeFlight application. This saves money on the licensing, but minimizes aircrew access to information when not on a mission. The iPad would be available only when that aircrew member is on a local or TDY mission without the ability to access information on the device at other times. Likewise, the boom operators do not necessarily need this application on their iPads. They are able to back up the pilots in their crew resource management (CRM) duties without this application on the iPad. This would reduce the annual cost by one third.

Another option is to use the NGA (National Geospatial-Intelligence Agency) provided free ForeFlight application. The NGA has a program to support relevant applications for use by DoD personnel. Because this is a priority for NGA, they have provided funding for this program and it is separate from any Air Force programs. The NGA has purchased license agreements for 8,000 ForeFlight applications. These may be applied for on an “as available” basis. “The request will be processed by our administrators on a first come, first served basis. As additional funding is available, more approvals will be granted.”²⁶ The NGA version is seamless from an aircrew perspective. There are a few administrative features that are not included, but this does not affect the ability to plan or execute the mission. This option saves money if it is available.

ForeFlight Safety

A focus on safety is required to reduce injuries, death, and keep the aircraft from damage or destruction. Safety is looked at from a prevention standpoint. The technology was analyzed to discover possible safety benefits from its use.

The ForeFlight application has the ability to keep records from the flight. It is called Track Logs.²⁷ This records the flight path and altitude and only requires 300kb per hour of storage space.²⁸ This information may be utilized along with the already established methods if there are any safety issues that did occur during the flight.

The Air Force does a really great job of learning from previous mistakes. This information from the Track Logs could be used during minor discrepancies to file an ASAP (Aviation/Airman Safety Action Program) report. “ASAP provides a non-punitive environment for the open reporting of safety concerns and information that might not be reported by other means... By providing early identification of needed safety improvements, ASAP offers significant potential for avoiding mishaps.”²⁹ This improves safety.

The ForeFlight application receives information from a Stratus ADS-B receiver while in-flight.³⁰ The Stratus with ForeFlight gives GPS position.³¹ This gives the aircrew the ability to see the aircraft on the charts, approach plates, and airfield diagrams. By being able to visualize where the aircraft is on the airfield, the route of flight, and the approach plate, the aircrew has better situational awareness in the decision making process that increases safety. An example of the benefits of this application to safety is when there is low visibility at an airfield. The taxiways and runways are shown with the position of the aircraft. Reference Figure 2 for a visual of the aircraft displayed on the Airfield Diagram at an airport. This helps the aircrew decipher where they are in relation to specific taxiways they need to turn onto and prevents them from accidentally entering a runway in low visibility.



Figure 2³² - ForeFlight Application on iPad featuring Airfield Diagram and aircraft overlay

Another area that required analysis was the security threat. This was a possible detriment to the use of the iPad. If the iPad was corrupted by an outside source the data could be cleared

out or inaccurate information could be displayed. This would result in the inability to use the device for information during the mission.

There are several steps that are taken to ensure that the iPad does not become corrupted. The ForeFlight application itself has security measures in place. All data sent to and from the application on the internet goes through the encryption process.³³

The iPad itself utilizes password protection and also utilizes McAfee security.³⁴ The password secures the device from an individual manually tampering with the software. The McAfee security program scans for possible viruses on the device as well as when information is sent and received by the device. This program continually updates with the most current anti-virus software to stay ahead of the threats.

A VPN (Virtual Private Network) is another way to secure the information coming into the iPad from a wireless connection.³⁵ A VPN is utilized at the 128 ARW to ensure secure Wi-Fi connection to the network from remote access. This product is administered by Communications Flight. The VPN ensures security throughout the system. The VPN grants access to the network based on validating an endpoint's state (antimalware, patch, disk encryption, etc.) and may have automated remediation actions or non-automated remediation actions to suite required Air Force policy.³⁶ This software ensures the device is not corrupted and the connection is secure.

If the threat was able to penetrate all of the security measures and corrupt the iPad, the benefit of the device is that it is not connected to the aircraft. The KC-135 aircraft systems and navigation would be unhindered by this threat. The iPad would not be able to be utilized for its benefits at this point. The aircraft would be able to complete the mission unhindered by the cyber-attack.

ForeFlight Flexibility

The KC-135 mission requires flexibility to meet the needs of the receivers and customers of their various support missions. This may mean altering course, timing or even changing destinations. The benefits of this criteria are passed on to the end user and their ability to accomplish their mission. The flexibility of the tanker mission provides global reach for the U.S. Air Force.

In the analysis, the ForeFlight application gives aircrew a great deal of flexibility on the go. The Stratus receiver allows the ForeFlight application to receive real-time weather information. The tanker crew may use this capability to make changes to the mission based on this new data. An example of the use of this capability would be monitoring thunderstorms along the route of flight. The flight path could be altered to avoid building thunderstorms. This increases safety.

Besides weather, the ForeFlight application also displays aircraft transmitting with ADS-B through the Stratus. This gives the pilots situational awareness as to where other aircraft are located in the airspace. Some of these aircraft may be Visual Flight Rules (VFR) traffic not communicating with ATC. ATC would not be providing traffic separation for these types of aircraft. The ability to see these aircraft along the route of flight provides an increased layer of safety among aircraft.

Another area found during the analysis that aids in flexibility is the information found in the ForeFlight database. Worldwide Flight Information Publication (FLIP) is included, giving aircrews the ability to see all jet routes for navigation. All airfields are also available, providing instrument approaches and departures as well as airfield diagrams. This provides flexibility to make changes to the mission when necessary because all required data is available to the aircrew at all times.

A consideration for using this application worldwide is the need for reliable internet. At U.S. Air Force and other U.S. military facilities there would be reliable internet access. The problem is encountered when flying into areas other than military bases, such as civilian fields. Utilizing open Wi-Fi sources overseas does not ensure security. There may be areas that don't have this capability even if it were secure. For the device to provide information on a worldwide, flexible basis, this access must be assured. The plan that the 150 SOS is pursuing utilizes smart phones while overseas. The smart phone would be utilized as a hot spot for the iPad to receive internet service connectivity in those situations where secure internet access is a problem.

This application definitely brings flexibility to a tanker crew while on a trip, away from home base. The use of this technology does have drawbacks. Just as the use of Wi-Fi must be balanced with security measures, the use of the cell phone as a hotspot also requires a high level of security measures. The same precautions must be taken when utilizing this technology. A passcode to access the cell phone locally is a requirement to deter tampering. The cell phone requires encryption as well as the utilization of the VPN to ensure that corrupted information is not being passed along to the iPad and ForeFlight application.

Conclusions

This research asked the question: "Would the utilization of the ForeFlight application on the iPad produce positive effects for KC-135 operations?" The research that was undertaken did find positive effects would be realized utilizing this ForeFlight technology for tanker operations. It is a value to integrate new technology into operations to realize benefits of these new and innovative devices and applications.

This technology is being utilized in the aviation realm. General aviation, commercial airline aviation and some military aviation units have all embraced the use of the iPad with the

ForeFlight application in the aviation community. These groups have all been able to realize positive effects from the utilization of this technology. They have been able to realize the benefits of increased efficiency, safety and flexibility.

The benefits of the ForeFlight Application on the iPad will provide efficiency, safety, and flexibility for mission planning and execution across the tanker fleet. Efficiency will be realized in reduced fuel usage and time savings. Safety is seen in increased situational awareness and reduced risk from developing weather phenomena. Flexibility is effected in ability to reroute and change the mission. These criteria were found to have value in the security, mission planning and mission execution phases of tanker operations.

Security

Security was found to be of vital importance to the safe operation of the device and ForeFlight application. The iPad is separate from the KC-135 aircraft and all of its systems so safe flight is not compromised. It is still important to ensure the information that is provided by this device is accurate and available. This way the benefits of the device may be realized. Several layers of cyber security are required. Security of the internet system with use of passwords, encryption, firewalls and VPN is required to keep the iPad from being corrupted.

ForeFlight continually updates the software to ensure the latest security threats are controlled. The application has free updates on a regular basis to keep the databases, software and security current. The ForeFlight website is the location to reference to ensure the latest version is being utilized.

Communications Flight should be involved in the initial setup of the system and all security updates. Communications Flight has taken on the work of the Cyber domain and is in place to reduce and eliminate cyber threats. They are the local cyber specialists in this new frontier. One of the regulations utilized by Communications Flight in regards to the Cyber

domain is AFI 17-101. This regulation covers Risk Management Framework (RMF) for Air Force Information Technology (IT) incorporating strategy, policy, awareness/training, assessment, continuous monitoring, authorization, implementation, and remediation.³⁷ All security programs and software are controlled by Communications Flight and a close working relationship is required to ensure the security needs for the iPad are being met.

The aircrew and mission planners in Tactics Flight have a part in mitigating security risks. Aircrews and mission planners should confirm security systems on iPad are current when turning device on for use prior to the mission. The device will be updated or replaced if a security threat is detected.

Mission Planning

The mission planning process includes requirements from both mission planners in Tactics Flight and aircrew. This includes all activities in preparation for the tanker mission. Planning begins with the full-time mission planning staff in Tactics Flight. The day of the mission the aircrew is provided all materials and resources from Tactics Flight to review and alter as necessary for the aircrew to execute the mission.

Mission planners have requirements to be completed before submitting all mission products to the aircrew to prepare for the mission. Mission planners check to ensure the iPad and all applications and publications are up to date. This includes checking that all security software is up to date and working properly. Mission planners are also required to ensure the flight plan is loaded onto the iPad. The fuel load of the aircraft must be input for accurate performance indications. The weather must also be overlaid on the route of flight.

Aircrew members have requirements to be completed before stepping to the aircraft. The iPad must be charged the day or evening prior to the mission. The aircrew must ensure that all information on the iPad is current, including software, flight plan databases and publications.

Aircrew also ensure that the flight plan is accurate for the mission. FLIP must be current and airfields that are utilized for that mission should be reviewed. All information and products provided by Tactics Flight should be reviewed and verified for accuracy before carrying out the mission.

The weather should be analyzed by the aircrew. The weather should be overlaid onto the route of flight. Any frontal activity or thunderstorms should be analyzed along the route of flight and flight plan altered if necessary. Winds should also be considered to account for optimization of cruise altitude.

Mission Execution

The aircrew is responsible for mission execution. This phase of operation is where the iPad with ForeFlight application truly stands out. The iPad should be utilized with the GPS function so that the aircraft is displayed on the moving map. This allows the ability to expand situational awareness on the ground while taxiing as well as show precisely where the aircraft is along the flight path while airborne. This improves efficiency and safety.

The weather should be analyzed on the moving map. Updating and analyzing the conditions throughout the flight increases safety and efficiency depending on the weather conditions. The weather along the air refueling track should be considered prior to beginning the Preparation for Air Refueling checklist thirty minutes prior to arrival at the air refueling track.

Besides the weather, traffic should also be monitored on the moving map. ADS-B traffic broadcasting their information show up on the moving map. Monitoring this traffic adds an extra layer of safety beyond that provided by ATC and onboard equipment. Some of these aircraft may not be communicating with ATC and this is a good way to keep them from coming into close contact with the tanker.

Flexibility is realized any time there is a change needed for the mission. The iPad with ForeFlight application should be used to update weather conditions, find information for unfamiliar airfields, and check the flight plan to ensure proper fuel loads and routing.

Recommendations

The use of the ForeFlight application on the iPad would bring positive effects to mission planning and execution of the KC-135 mission based on this research. This application should be utilized to bring efficiency, safety, and flexibility to tanker operations across the fleet. The utilization of the application will bring these benefits to all KC-135 forces, active, guard, and reserve.

Implementation of the use of ForeFlight on the iPad for the KC-135 requires policy guidance to exact change across all tanker units. Recommendations for this implementation include changes to incorporate the use of this technology into mission planning and execution operations as well as added verbiage into KC-135 publications and local unit operating procedures. The recommendations bring policy changes to the KC-135 community for implementation of the ForeFlight application for use on the iPad. These publications include the AFI 11-2KC-135V3 and KC-135R/T In-Flight Guide as well as several locally created documents. The locally created documents will use the 128 ARW as an example for implementation. Publications affecting the KC-135 that require change are the AFI 11-2KC-135V3, AFI 11-2KC-135V3 128 ARWSUP1, KC-135R/T In-Flight Guide, 128 OG OI 11-1, Tactics Daily Checklist and Mission Planning Checklist.

AFI 11-2KC-135V3

AFI 11-2KC-135V3 is a KC-135 specific Air Force Instruction. It details the operations of the KC-135 and is applicable for all KC-135 operations. This document should be updated to include further verbiage on the usage of portable electronic devices (PEDs) under Chapter 5,

5.9.³⁸ This section focuses on personal devices. It needs to include a discussion of the use of professional PEDs and the ability to utilize them during flight. Restrictions should be noted to use when classified information is open in the cockpit.

AFI 11-2KC-135V3 128 ARWSUP1

AFI 11-2KC-135V3 128 ARWSUP1 is the 128 ARW supplement to the AFI 11-2KC-135V3. This is a local document at the 128 ARW that adds detail for specific operations at the wing and any areas where the 128 ARW requires more restrictive actions than the parent document. The supplement cannot contain less restrictive instructions than the parent document.

Changes to this document would be made by adding 5.9.³⁹ This section should state the local usage guidance of the iPad with ForeFlight application. This would be approval of usage as a mission planning and execution tool.

KC-135R/T In-Flight Guide

The KC-135R/T In-Flight Guide is a non-regulatory guide for aircrews. This guide contains quick reference information pertinent to normal operations as well as information about practice exercises.

This In-Flight Guide is a good reference for aircrews. A section should be added to include a quick reference guide to the normal operating procedures with the use of the iPad with the ForeFlight application. This will include such techniques as how to access the application, reference airports, reference high and low charts, overlay the aircraft position on the moving map, overlay the weather, access the flight plan and how to see the winds at varying altitudes.

128 OG OI 11-1

The 128 OG OI 11-1 is also a local document for the 128 ARW. Operating Instructions may be utilized by any Air Force unit and this is an example of how the information should be incorporated into any tanker organization operating instruction. This document steps through the

local mission preparation and planning process detailing the role of each shop from a safety standpoint.

The utilization of the iPad and ForeFlight application should be incorporated into the Operating Instruction. This information applies under section 6.3, Flight Planning Software.⁴⁰ This document is the recommended place to outline the responsibility of the Chief of Tactics to ensure that the iPad is current and updated with all applicable mission planning and execution material. The software and security updates need to be current as well as flight plan databases.

Tactics Daily Checklist

The Tactics Daily Checklist is a local product utilized by Tactics Flight to ensure all mission planning steps are taken to prepare for local and off station flights for the KC-135. Steps are required to be added to the checklist for mission planners in the Tactics Flight to load relevant information into the ForeFlight application and ensure the application is current and up to date.

Mission Planning Checklist

The Mission Planning Checklist is used by aircrew members prior to a flight to ensure that all materials are gathered and reviewed prior to a mission. This checklist requires updated checklist steps to ensure that information loaded and updated by the Tactics Flight are reviewed by the aircrew. The aircrew is required to verify all information on the iPad and ForeFlight application and also make any changes to the flight as they see fit. The aircraft commander is ultimately responsible for the successful execution of the mission.

Summary

Efficiency, safety, and flexibility are key factors to improve the global reach of the KC-135 fleet. Efficiency of operations saves AMC and the Air Force money because of the size of the tanker fleet. Safety reduces the likelihood of a mishap from occurring, saving lives and

resources. Flexibility is important to the tanker community because of the customer focused mission of the KC-135 and the need to be at the position where the customer needs them whenever required.

Recommendations based on the results of the evaluation criteria and findings were made. The recommendation was made to implement the use of the ForeFlight application on the iPad into the KC-135 operations. Crewmembers and mission planners from Tactics Flight would be involved in the implementation and use of this technology during the mission planning and execution phases. Communications Flight would be instrumental in the initial security setup and security updates. This implementation would involve the update of KC-135 specific publications to reflect the usage of this technology and their restrictions. It would also involve the update of local instructions, guides and checklists for the tanker community to implement the technology into daily operations.

As with all research and technology, there is always room for improvement and growth. An area for further exploration and research that would further improve flexibility would be global military access to internet services. The ability to connect an electronic device to secure internet anywhere on or above the globe would revolutionize many areas of the military far beyond the tanker community's ability to access features of the ForeFlight application.

Technology has made life better in most aspects of daily life. Electronic devices have become integral parts of both personal and professional daily activities. Their integration will continue to improve daily processes. KC-135 operations must continue to evolve to stay relevant. The tanker may be old, but there is still room for implementation of new technologies to better the mission planning and execution process to ensure that receivers get their gas when and where it is needed and save tax payer dollars in the process. With the swipe of a finger, the antiquated technology of the tanker may be launched to modern heights.

Notes

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- ⁴ John Zimmerman, “More Than Just a Gadget: How the iPad is Making Flying Safer”, *Plane and Pilot*, June 2016, 48-53.
- ⁵ “United Airlines, Cleared For Takeoff With iPad”, Apple, Copyright 2016, <http://www.apple.com/ipad/business/profiles/united-airlines/>.
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- ⁷ JP 3-17, *Air Mobility Operations*, 30 September 2013, II-1.
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- ¹³ Col Michael Guch, “Operations Group Focus Areas for the 128 ARW,” 2016.
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- ¹⁵ Jennifer Griffin, “Air Force, Facing Fighter Pilot Shortage, Offers Retention Bonuses of Up to \$225,000,” *Fox News, Politics*, 26 July 2013, <http://www.foxnews.com/politics/2013/07/26/air-force-facing-fighter-pilot-shortage-offers-retention-bonuses-up-to-225000.html>.
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- ¹⁸ Staff Sgt. Janelle McRae, Secretary of the Air Force Public Affairs, “‘Make Every Dollar Count’ Continues, Adds New Initiatives,” *U.S. Air Force*, 19 January, 2017, <http://www.af.mil/News/ArticleDisplay/tabid/223/Article/1054251/make-every-dollar-count-continues-adds-new-initiatives.aspx>.
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- ²¹ “2016 Index of U.S. Military Strength,” Heritage Foundation, 2017.
- ²² Travis S. Root, “SOFWERX PEO-FW COLLABORATION, ForeFlight Performance: Advanced Fuel Planning for the Mobile EFB,” 23 January 2017.
- ²³ “Pilot’s Guide to ForeFlight Mobile”, 34th Edition, ForeFlight, LLC, 66.

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