A COMPARISON STUDY OF F-15C
FIGHTER SQUADRON READY AIRCREW
PROGRAM FLYING HOUR SCHEDULING
VS. THE RAND CORPORATION'S FLYING
HOUR SCHEDULING LINEAR PROGRAM

GRADUATE RESEARCH PROJECT

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

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Abstract

This research compares and contrasts the Flying Hour model created by the RAND corporation with the Ready Aircrew Program (RAP) model from Air Combat Command. The RAP model was designed to generate an annual flying hour program that specifies the minimum number of sorties required to stay tactically safe. The RAND model was designed to provide fighter pilots 13 sorties per month, a number determined from surveys of combat aviation leadership. The RAND model is built on the assumption that the fighter pilots would be immediately ready to deploy to a combat situation. In contrast, squadrons using the RAP model must take extra sorties and time to get fighter pilots ready for war. This research recommends an increase to AFI 1-2F-15V1 annual pilot requirements. This plus-up will increase average monthly sorties for combat mission ready API-1 pilots to the Air Force Safety Center recommended 11 flights per month at a flying hour cost of approximately $1.7 million per squadron.

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Christopher P. Levy

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1. Introduction

Background

The United States Air Force entrusts commanders with the responsibility of ensuring pilots are ready to accomplish their combat missions when called upon. However, if interpretation were left to each individual commander, the definition of "ready for combat" would take on numerous variations and could negatively impact the overall readiness of the Air Force.

As a result, the Department of Defense defines *readiness* in Joint Publication 1-02 as follows: "The ability of US military forces to fight and meet the demands of the national military strategy"(11). In contrast, the RAND Corporation defines it as measuring the ability to go to war and carry out certain assignments in a timely manner (10).

To create uniformity of readiness across the spectrum of fighter squadrons, Air Combat Command (ACC) created the Ready Aircrew Program (RAP) in 1997 (16). Through RAP, ACC ensures fighter pilots are combat ready by mandating certain training events be accomplished during each training cycle. RAP lists, by specific aircraft type, details about the *minimum* number and types of training sorties to be flown by fighter pilots. For example, an experienced F-15C pilot must accomplish 27 Basic

Fighter Maneuvers (BFM) sorties within the 20 month RAP training period or risk losing status as a combat mission ready fighter pilot (2).

In 2003, the RAND corporation, at the request of the Air Force, conducted a study to look at the number of fighter sorties necessary to ensure combat readiness of a fighter squadron. The result was a linear model that predicted the number of sorties required based on the number of pilots having varied qualification levels assigned or attached to a squadron. Using linear regression, RAND created a meta-model. In doing so, any commander is now able to use this model for flying hour program development (7).

Using the RAP flying hour model, F-15C fighter squadrons have a very difficult time meeting all of the RAP requirements each training cycle. A 2002 report by the RAND corporation supported what most 'old-timers' have been saying for several years, that our Air Force is not as prepared as it used to be.

> The concern over how to allocate very scarce resources is only one of the reasons. At the heart of the issue lies the problem of determining when readiness has sunk below an acceptable standard, and there is increasing suspicion that much of the U.S. military recently crossed that threshold" (10).

The Air Force is currently conducting an internal audit of the F-15C flying hour program to ensure each squadron has executed all contracted flying hours (4). The audits also look at whether or not the pilots finish all of their RAP requirements during the RAP training cycles. A 2005 audit of the 71st Fighter Squadron at Langley AFB, VA, conducted by the Atlantic Area Audit Office included the following report:

> Aircrew did not always accomplish required continuation training requirements and shortfalls were not always reported to Air Combat Command. Specifically: 10% of Combat Mission Ready (CMR) experienced pilots, 80% of attached CMR pilots, and 40% of BMC attached pilots reviewed did not fly the annual events by type as [per] the RAP tasking message (5).

Reasons cited by the audit for the squadron failing to achieve the minimum number of sorties include deployed aircraft, squadron spin-up for OPERATION IRAQI FREEDOM, and an excessive number of days when it was too hot and humid to safely fly.

ACC is using the minimum requirements for RAP as a guide for flying hour funding levels despite contradictory guidance in Air Force Instruction (AFI) 11 2F-15V1, *F-15 Aircrew Training*. The instruction says, "The standard sortie requirements… establish the minimum number of sorties per training cycle BMC and CMR levels of training" (13). However, later in the instruction, it states that flying the minimum number of RAP sorties may not provide enough experiencing sorties to mature combat aviators quickly enough to keep experience levels at appropriate levels, "RAP sorties may not provide sufficient hours to experience pilots to achieve overall unit experience levels" (13).

Flying only minimum RAP sorties results in pilots flying on average 8 to 10 sorties per month. The RAND model recommends a significantly larger number of sorties per month. Their study found that the combat squadron commanders wanted their pilots to have 13 sorties per month to be combat ready (7).

The difference between ACC's RAP model and the RAND model is significant. At the current flying rate, F-15C squadron commanders feel their pilots need a spin-up time period in which to fly at a higher sortie rate to prepare their pilots before deploying to a combat area. The RAND model is built on the premise that these pilots would be ready for combat without needing a spin-up period.

Problem Statement

This research will explore the differences between the RAP and the RAND flying hour models. The intent is to shed light on those differences and reveal any training shortfalls of the RAP model. This paper will validate the constraints of the RAND linear model and ACC's RAP model and then use data from actual F-15C fighter squadrons and input it into each model. The results will be compared and analyzed. The F-15C community at large will be the benefactor of this research. While this work is specifically sponsored by the 1st Operational Support Squadron, Langley AFB, VA, data is supplied by six different F-15C fighter squadrons from around the world.

Research Objectives

For many years, the F-15 community has struggled with successfully creating a yearly schedule that allows for the completion of all training requirements. Due to the limited number of flying hours given to the squadrons by ACC, fighter squadrons find it nearly impossible to effectively complete all of the RAP required training events into each training cycle. This research seeks to establish an objective rationale to oppose further reductions in flying hour money and to coordinate with aircraft maintenance organizations to increase the aircraft utilization rate (UTE), defined as the number of times each aircraft is flown each month.

If the RAND model were to be used by ACC for allocating flying hour funding, the cost of the F-15C flying hour program would increase dramatically. Complete implementation of the RAND model will likely prove to be infeasible. The UTE rate shows, on average, how many times each aircraft in a squadron is flown each month. If the UTE increases, a squadron can fly more sorties per month, thus making it easier to complete all training requirements.

Methodology

This study compares the results obtained from the RAND and RAP models. Every fighter squadron maintains a document called the "letter of X's" (LOX) that allows the operations officer to have one document that shows all of the qualifications of every pilot in the unit (Appendix A). Data from the LOXs from 6 different F-15C squadrons will be used to determine the distribution of qualifications of the pilots. These numbers for each squadron will be input into both the RAND and RAP models to determine the recommended number of flying hours for the year. By comparing the differences between the two models, the large increase in numbers of sorties required by the RAND model will be highlighted and used to investigate further why the extra sorties were generated. Additionally, the RAP model will be modified to increase the monthly number of sorties to either Air Force Safety Center or RAND recommended levels.

Assumptions / Limitations

The RAP calculation spreadsheet provided by ACC/A3TO has the capability to change the flying hour recommendation based on squadron deployments to contingency operations and aircraft downtime. The contingency operation input allows squadron planners to indicate the number of aircraft deployed and the number of months deployed. These numbers are used, in concert with longer average sortie durations (ASDs) and lower UTE rates to increase the number of sorties flown per pilot. The number of annual hours does not change. The aircraft downtime input allows squadron planners to indicate periods of decreased UTE for a certain number of aircraft, which has the affect of decreasing the annual flying hour calculation. For simplicity, the contingency operation and aircraft downtime inputs are held at zero.

The Air Force uses Aircrew Position Indicator (API) to differentiate between pilots who are fully ready for war and pilots that need additional training before deploying for combat. API-1 pilots are at the highest state of readiness. These pilots fly enough sorties to maintain Combat Mission Ready (CMR) status. CMR means "maintain[ing] proficiency and qualification in all core missions of the flying unit to which they are assigned or attached" (13).

API-6 pilots are usually more experienced pilots who have at least 500 hours of flying time in their particular airframe and do not need as many sorties to maintain proficiency. If the squadron were to deploy to a combat zone, the API-6 pilots must be able to reach combat readiness with 30 days of increased training. API-8 pilots are usually staff officers who are required to maintain flying currency for job related duties. They do not need to maintain combat readiness and will not be called upon by the unit to help in a combat deployment (13).

The RAP model allows for the inclusion of API-8 staff pilots in the calculations. To decrease the number of variables, the number of API-8 pilots used in the calculations was set at zero. The overall impact of adding these API-8 pilots back into the calculations would be negligible as they only fly 60 sorties per year. Thus, a squadron with only one API-8 attached pilot would have to add 60 sorties to their yearly total. This equates to just over 1% of the total number of sorties flown annually.

The RAP spreadsheet allows planners to change the number of cost of business (COB) sorties flown per year. COB sorties are sorties used for cross-country training, air show support, collateral sorties, attrition sorties, and scheduling efficiency. Each squadron will have a different cost of business level based on several factors, but ACC/A3TO recommended using 20% as the planning factor, and this study uses this figure (15).

The major limitation of this study is the lack of a control group. The ideal experiment would entail a control squadron that continues flying at its current rate and a variable squadron or squadrons that fly an increased number of sorties per month. At the end of a given time period, certain metrics would be measured within each squadron and compared to look for statistical differences. Ideal metrics might include experience level within the squadron, upgrade sortie pass rates, speed of upgrade completion, or even direct results in a series of comparison combat exercises. This study must remain theoretical and make inferences to the flying world.

The RAND study assumptions were reviewed and found to be sound, save for the requirement of 4 night sorties per year per pilot, instead of the 12 to 13 night sorties now required by regulation.

II. Literature Review

Historical Perspectives

Since the beginning of military aviation, pilots and finance officers have been at odds with each other. Pilots want to fly as much as possible, but flying costs money. Hourly F-15C flight costs are approximately $5,013.00 in 1997 constant dollars (21). Thus, finance officers attempt to limit flying hours to only those required to ensure all training and readiness needs can be met. Air Combat Command created RAP as a way to ensure sufficient flying training takes place to keep pilots ready for combat. RAP identifies the minimum numbers of sorties that must be flown by each category of pilot during a set time period.

When organized flying began, there were no formal programs in place to ensure pilots received the necessary training. Orville and Wilbur Wright gave a few cursory lessons to new pilots and then sent pilots off by themselves to learn on their own. The new pilots learned by trial and error and by correspondence with the Wright Brothers. The knowledge base about flying did not exist at that time. Each flight often led to a discovery of a previously unknown facet of flying (3).

During World War I, pilots received only primary flight training in the United States, and gained expertise primarily via on the job training. Canadian primary training, indicative of training in the United States Army Air Corps, was just 6 weeks, with student pilots earning solo qualification after only 6 hours of flight time (19). When compared to the typical 10-15 hours a civil pilot flies prior to solo qualification, it is easy to understand how inexperienced the military pilots were during this period.

World War I pilots were taught combat tactics only after they arrived in theater (22). This practice led to large combat losses. If a new pilot could make it through the first couple of sorties, the probability of survival increased.

During the build-up for World War II, pilots received both basic training in a slow aircraft and advanced training in a higher performance aircraft. Once training was completed, they reported to a unit to continue training until the unit shipped overseas. They were shipped directly to combat after training was completed and, as before, gained experience via actual combat.

As aircraft increased in speed and complexity, the need for more realistic and constant training became evident. The kill ratio in Korea was acceptable at 13 to 1, but in Vietnam it dropped to almost 2 to 1 before the United States took dramatic measures to improve it. The Department of Defense instituted realistic combat training experiences such as Red Flag, Top Gun, USAF Fighter Weapons School, and Cope Thunder. These exercises and schools exposed pilots to the stresses and chaos of combat, thus greatly improving their chances of survival once arriving in the combat zone.

Combat Readiness

David Carleton highlighted an important phenomenon in combat readiness. Air Force combat pilots enter periods of conflict at a reduced state of readiness and gradually increase capabilities until peaking near the end of the conflict. After combat ceases, the readiness of the pilots rapidly decreases back to a peacetime level. This decreased readiness level leads to combat losses at the beginning of the next conflict. Those that survive early combat gain critical experience that enhances the chances of later survival (9).

To decrease combat losses and improve mission effectiveness, the Air Force created a program designed to keep the pilots' readiness state at a combat level even during peacetime. The first attempt at this was by identifying the "minimum number of hours and events (such as instrument landings), which a pilot was required to complete in each six month training period" in Air Force Regulation 60-1 (9). Additionally, for combat pilots, the Air Force used tactics manuals which established lists of training events to prepare for combat. Thus, a fighter pilot could look in these manuals and determine how many flights with events such as strafing attacks, 20^{o} bombing runs, 1 vs. 1 combat engagements, and so on, which were required during any given period.

In order to ensure the completion of the required events, the Air Force must plan and budget for the number of flying hours for each pilot for each month. The crucial task in this process is to determine the minimum number of sorties required per month to ensure the readiness of the combat pilots. Excessive hours waste Air Force resources which could be used towards other projects, such as the acquisition of new aircraft or the improvement of base infrastructure. Too few hours and the combat pilots pay for it with their blood.

During the Cold War, pilots had to maintain an enhanced state of readiness for many years. Fighter pilots had to continually practice their craft to ensure they were ready if the Cold War intensified to armed conflict. Early in the 1970s, the Air Force budgeted for every combat pilot to receive 20 hours of flying time per month (9). Using today's ASD in an F-15C unit of 1.2 hours, 20 hours equates to 16.7 sorties per month. However, due to the 1973 energy crisis and associated oil embargo, Tactical Air

Command (TAC) reduced the monthly flying hour allotment of its combat pilots from 20 to 18 hours.

As a result of the increasing cost of fuel, the Air Force again looked at the possibility of reducing the number of flying hours per month. Air Force regulations stipulated only the minimum numbers of events to be flown. Many pilots actually flew more than this required amount. Additionally, the exact number of events flown was not reported, only whether the minimum number was met. Thus, ACC began to view the minimum as sufficient despite the fact that the high levels of readiness were a result of the actual flying training events.

In order to safely reduce the number of flying hours given to each pilot, the Air Force decided to have squadrons train for specific mission areas rather than for all missions. For example, even though the F-4 Phantom could do Close Air Support (CAS), Combat Air Patrol (CAP) and Suppression of Enemy Air Defenses (SEAD) missions, the Air Force tasked each individual squadron with a particular mission in which to specialize. In 1974, that specialty became the squadron's Designed Operational Capability (DOC). The pilots in a fighter squadron would focus their training on their DOC mission and let their proficiency with their aircraft's other missions decline. In this way, the Air Force could reduce the amount of flying hours per pilot and reduce the resources being spent on flying training.

The DOC system also allowed for differing numbers of sorties to be given to each pilot based on experience level. A brand new wingman would receive more sorties whereas a more experienced pilot would receive fewer sorties. The DOC system allowed the Air Force to assign up to 3 missions to multi-role aircraft squadrons, "two at the [mission ready] proficiency level and one at the [mission capable] level" (9). Mission Ready is defined as readiness for a wartime combat environment—ready to go to war. Mission Capable is a reduced state where a pilot can perform basic mission requirements but lacks the proficiency necessary for combat operations.

Graduated Combat Capability

To cope with the different levels of proficiency, the Air Force created the precursor to the RAP program, called Graduated Combat Capability (GCC). With GCC, the Air Force established numbers of sorties to be flown for both experienced and inexperienced combat pilots. GCC also specified specific events within each training sortie that had to be accomplished in order to be an effective training mission.

Additionally, each weapon system on an aircraft was considered a separate capability and was allocated training sorties and events to ensure readiness. These training requirements were created by breaking down each capability into the basic events: "(1) those being the sorties required to accurately deliver the weapons, (2) the training necessary to get the weapons to the target, and (3) the training required to negate the defenses, aircraft, surface-to-air missiles, electronic countermeasures, and anti-aircraft artillery that would be encountered on the ingress and egress to the target" (9).

One other factor which, by design, led to the decrease in flying hours allocated to each pilot was the mission simulator. Simulators have been used in flying training since World War II when the Link Corporation developed an enclosed trainer for instrument instruction (18). As the fidelity increased, the lure to use this relatively low cost alternative and reduce the flying hours became very strong.

The advantage of simulators is that pilots still get valuable training at a fraction of the cost and without the risk of losing valuable personnel or equipment. According to David Carleton, the savings for an Air-to-Air wing in 1978 dollars using simulators to replace 27% of the flying saved $7.5 million. A key, and sometimes overlooked disadvantage, is that simulators are only part task trainers that never completely replicate actual operations. Pilots still require actual aircraft experiences to gain proficiencies needed to fly and survive in combat.

By 1997, the GCC had evolved into classifying combat pilots into 3 different levels based on pilot proficiency. GCC Level A identified pilots trained in their aircraft's primary mission. GCC Level B identified pilots qualified for A and "additionally trained to support the specific units tasking(s) and/or specialized/collateral tasking requirements" (16). GCC Level C identified pilots qualified in every mission of their aircraft. The number of sorties per pilot per year is shown in Table 1 (16). The two numbers in each column represent the typical sortie requirement for inexperienced and experienced pilots. The term "experienced" usually means a pilot has over 500 hours in his weapon system.

Table 1. ACC F-16 Pilots Annual GCC Sortie Requirements (Inexp/Exp) (16)

Cycle	**GCC Level A**	**CGG Level B**	**GCC Level C**
GCC Total	96/84	140/120	184/156

According to Table 1, in 1997, a GCC level C inexperienced pilot needed 184/12 = 15.33 sorties per month and an experienced pilot needed 13 sorties per month. From 1973 to 1997, the number of sorties required for combat readiness had dropped from 16.7 to as low as 7 (for a GCC level A experienced pilot).

Major David Ellis observed that during the Cold War, ACC strived to maintain 100% of its combat pilots at GCC C. By 1997, however, that goal had been reduced to keeping 70% of the combat pilots at GCC B (16). The decrease in combat readiness was a direct result of the United States being involved in several lengthy no-fly zone enforcements: OPERATION NORTHERN WATCH, OPERATION SOUTHERN WATCH, and OPERATION DENY FLIGHT, among others. During this type of operation, combat pilots got very little proficiency training. In fact, the readiness levels trended exactly opposite those observed during combat.

In combat, readiness levels increase as the operation continues. In a no-fly zone enforcement, where the pilots patrol airspace for long periods, with few or no engagements, their combat readiness decreases dramatically. In the current Air Expeditionary Force (AEF) cycle, ACC plans for 1-2 months of recovery time to return a squadron to combat readiness again after being in a no-fly zone operation. In terms of training, no-fly zone operations are ineffective and, in fact, place a tremendous burden on the squadron once it returns home to regain even an acceptable peacetime readiness level.

The GCC program allowed for further reduction in the readiness of the combat force by discounting annual training requirements by the duration spent in no-fly zone operation. The number of sorties required for each level was prorated based on the number of months the squadron was deployed. Thus, if a squadron was gone for 4 months, then the pilots only had to fly 2/3 of the annual requirement for a particular level. Pilots were being reported at a certification level despite having not flown what was documented as required (16).

Ready Aircrew Program

As a result of the under reporting of readiness deficiencies, in 1997, Air Combat Command did away with GCC and created RAP to prevent readiness levels in fighter squadrons from falling to unacceptably low levels. The ACC training division's goal was to "make training missions more efficient by linking required sortie types more closely to unit operational and contingency taskings" (16).

RAP was originally a 12 month program running from 1 October to 30 September. RAP "is the CT [continuation training] program designed to focus training on capabilities needed to accomplish a unit's core tasked missions. Following completion of IQT [initial qualification training] and MQT [mission qualification training], pilots will have received training in all the basic missions of a specific unit… Pilots will then be assigned to either a Combat Mission Ready (CMR) or Basic Mission Capable (BMC) position." (13)

The basics of the RAP program for the F-15C are published in AFI 11-2F-15V1, but updates are sent directly to the units in the RAP tasking message. ACC/A3T sends out the RAP tasking message on an 'as needed' basis. This message contains updates regarding the minimum number of each type of sortie and each type of task to be accomplished by F-15C pilots. The RAP training cycle was just recently changed from a 12 month to a 20 month rotation to align with the AEF cycle.

Bigelow, et al, describe the RAP program as follows: "The RAP model was intended to establish the minimum sorties required for training aircrews in operational squadrons and to justify that minimum in the budget process" (7). However, it was developed when fighter squadrons were full of experienced pilots. Since then, a shortage of fighter pilots has forced the Air Force Personnel Center to fill squadron billets with young lieutenants to maintain force strength. The resulting lopsided experience levels force the few experienced pilots to fly far more sorties than their minimum levels since the majority of sorties for the inexperienced pilots are flown on the wing of an experienced pilot.

The RAP model starts with the minimum numbers of sorties for each category of pilot given in AFI 11-2F-15V1. It then adds a COB factor. This study uses the previously discussed 20% recommendation from ACC/A3TO. There is no change to sortie numbers based on a change in squadron experience level. In the RAP spreadsheet, experience level is only used to determine the number of API-1 pilots in the squadron.

Each squadron is allocated pilot positions based on the number of aircraft assigned, using a crew ratio defined as "the funded number of crews required to support the unit mission, based on a particular aircrew complement, for each [Primary Aircraft Assigned for Wartime Mission] (PMAI)" (12). The ratio for the F-15C is 1.25. For example, if a squadron possesses 18 aircraft, they are authorized to have 23 (22.5, rounded up) API-1 pilots in the squadron. The squadron may have more pilots flying with them, but such pilots are actually assigned to other units within the wing and are only "attached" to the fighter squadron for flying purposes.

In the instruction, the stated aim of RAP sorties are to

> "emphasize either basic combat skills, or scenarios that reflect procedures and operations based on employment plans, location, current intelligence, and opposition capabilities. Use of procedures and actions applicable to combat scenarios are desired (e.g., appropriate use of code words, authentication procedures, combat tactics, safe recovery procedures, tactical deception, in-flight reports, threat reactions, Intel briefing/debriefing). Tactical training will include use of inert and live ordnance, threat simulators, countermeasures, and dissimilar aircraft as much as possible." (13)

RAP sorties lead to basic and combat mission skills and non-RAP sorties build basic pilot skills such as instrument, advanced handling, and navigation. The RAP tasking message lists the non-RAP sorties and events in table form for a 20 month cycle (Table 2).

Table 2. Non-RAP Sorties and Events (2)

REQUIREMENT	BAQ	BMC	CMR	REMARKS
AHC	3	3	3	
Instrument Sortie	7	7	7	
Trail Departure	0	13	13	50% may be accomplished in the MTC
Night Sortie (inexp/exp)	7/7	10/7	22/20	See Vol 1 definition
Penetration	20	20	20	Min 7 no HUD and 50% may be accomplished in the MTC
Precision Approach	27	27	27	Min 10 no HUD and 50% may be accomplished in the MTC
Non-Precision Approach	27	27	27	Min 10 no HUD and 50% may be accomplished in the MTC
Trail Arrival	0	7	7	50% may be accomplished in the MTC
SSE approach	10	10	10	50% may be accomplished in the MTC
No Flap approach	10	10	10	50% may be accomplished in the MTC
Minimum Total Sorties	80	120/100	183/163	(Inexp/Exp)
Instrument/EP SIM (Note 17)	7	7	7	Units that don't have an MTC, FMT, WTT, should utilize the CFT, CPT. Sim instructors and FEs may log two of these missions from the instructor station. Will be supervised by SIM IP or IP. Max of 2 may count for DMO time. 50% will reference night procedures.
Tactical SIM (Inexp/Exp)	17/13	17/13	17/13	The MTC, FMT, WTT, or NTC-L may be used. Max of 10 may be counted for DMO time. 50% will reference night procedures.
Chemical Warfare SIM	0	0	0	Once per career. See Table 4.1 for refresher requirements. Not required for TF/CB Coded Units

AFI 11-2F-15V1 lists the minimum number of sorties required for F-15C fighter pilots by year (Table 3) and the RAP tasking message lists the sortie numbers for the 20 month cycle (Table 4). Both charts result in the same monthly sortie breakdown. For example, an inexperienced CMR pilot must fly at least 110 sorties per year, or 9.2 sorties per month, in order to maintain CMR status. For experienced CMR pilots, that monthly minimum is 8.2.

Table 3. Annual F-15C RAP Sortie Requirements (13)

MAJCOM	Cycle	BMC Inexp/Experienced	CMR Inexp/Experienced
ACC, USAFE, PACAF, AETC	RAP Total	72/60	110/98
	3-Month Lookback	18/15	27/24
	1-Month Lookback	6/5	10/9
ANG	RAP Total	72/60	90/76
	3-Month Lookback	18/15	23/18
	1-Month Lookback	6/5	7/6

Table 4. Total Sortie Requirements (Inex/Exp) (2)

	BMC	CMR
20 Month	120/100	183/163

The RAP tasking message also breaks down the number of each type of sortie that must be flown in that 20 month cycle. Table 5 shows the minimum number of sorties for both experienced and inexperienced pilots.

Table 5. Sorties per Training Cycle (2)

Sortie Type	BMC	CMR
Air to Air Night	10/10	22/20
DCA	N/A	25/18
OCA	N/A	25/18
ACM	10/7	17/14
BFM	10/7	30/27
Red Air	N/A	60/60
CC Option	100/86	26/26

It is one thing to discover the number of sorties allowed per month as driven by dollars and combat training. It is another to look at it from a safety perspective. Lieutenant Colonel Rick Burgess attempted to answer the question of how many sorties are needed by combat pilots each month from a safety perspective (8). He found that in 1998, Pacific Air Forces (PACAF) API-1 fighter pilots flew, on average, 9.6 sorties per month. However, he noted that an Air Force Safety Center (AFSC) report had determined the minimum number of sorties for the average fighter pilot to maintain adequate proficiency was 11. The implication from his study is that such deficient sortie rates, and the corresponding loss in proficiency level is such that accidents are more likely and there is reduced combat readiness. Unfortunately, the AFSC report was not available for reference, nor could the AFSC provide corroboration of this number.

Flying Schedules

Creating a flying schedule that maximizes the use of the limited resources is a daunting task. A fighter squadron Operations Officer and his staff must take the limited allocated flying hours and generate a schedule that is largely driven by maintenance considerations in order to meet training requirements.

After accounting for weekends, holidays, and planned down days, the scheduling process begins by assuming approximately 245 flying days annually. However, this does not include days that will be lost due to weather conditions or maintenance issues. Historical experience guides the expected number of days to be discounted for planning purposes.

The flying hour program officer must also coordinate with maintenance to determine the number of jets which can be generated each day. Fighter squadron flight operations usually operate in “go’s”. A go is a time period during which several aircraft launch in rapid succession. That lets maintenance concentrate on 8-14 aircraft and get them operational and flight ready. Those aircraft will all launch within approximately 30-45 minutes of each other.

The number of sorties a maintenance organization can generate stems directly from the aircraft UTE. UTEs for F-15C squadrons currently average around 17.5.

Multiply that by the number of jets possessed by the squadron and by 12 months, plus an overage that takes into account the planned attritions yields the number of sorties a fighter squadron needs to accomplish its mission. Once the flying hour officer has the number of sorties for the year, it is multiplied it by the average sortie duration (ASD), or average length of the sorties, to obtain the number of flying hours necessary.

There are many places to adjust the numbers to achieve a predetermined result that fits the available data. If ACC can only afford a certain amount of flying hours for a squadron, they can tell the squadron to lower their ASD or lower their UTE to compensate. For example, if ACC gives a 24 PMAI fighter squadron 6000 hours for the year, but the squadron needs 6117.12 hours to successfully execute their training plan, ACC has the option to ask the squadron to decrease their UTE from 17.7 to 17.36 or decrease their average ASD from 1.2 to 1.17. Maintenance would like the decrease in UTE as it is less of a burden on them to generate fewer aircraft per day. However, operations suffers either way; reducing the length of the sorties or reducing the number of sorties, pilots lose necessary training opportunities.

AFI 11-102, *Flying Hour Program Management*, explains how a flying hour program should be created (14). In their model, the only variables are number of jets, number of pilots, and the pilots' training requirements. Nowhere in this model does the number of jets available from maintenance appear. The pilot to jet ratio of 1.25 should take maintenance production rates into account. The formula in AFI 11-102 is shown graphically in Figure 1.

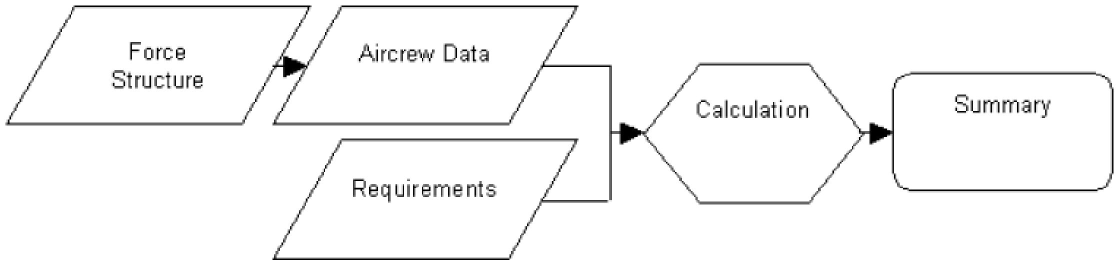

Figure 1. The Air Force Single Flying Hour Model (14)

Force structure determines the number of pilots and pilots multiplied by requirements determine the number of flying hours required for a training program. This thought process is more in line with the flying hour model created by the RAND corporation.

The RAND Model

In 1946, General H. H. “Hap” Arnold contracted with the RAND organization “as a way of retaining for the United States Air Force the considerable benefits of civilian scientific thinking that had been demonstrated during World War II” (1). Project Air Force is an ongoing effort to provide analytic support for research programs.

In 2003, the RAND organization, as part of Project Air Force, published a report titled “Models of Operational Training in Fighter Squadrons”. The authors, Bigelow, Taylor, Moore, and Thomas, attempted to encapsulate fighter squadron training in a linear model and define a series of constraints in order to minimize the number of training sorties required to determine how many annual flying hours were necessary for a fighter squadron to accomplish all of the training required by regulation. For a complete look at the objective function and the constraints, see Appendix B.

Bigelow, et al, started with an F-16 squadron as their system and then modified their model for other weapon systems. The model is based on both sortie minimums and experience accrual. The modelers assigned experience points to each type and version of a sortie and created a requirement for a pilot to obtain a certain amount of experience during each month for appropriate skill progression. The model also accounts for pilot upgrades, which are sorties where the bulk of the training is for one individual as they train for the next highest pilot qualification. Additionally, the model inputs sorties for Red Air, which are F-15C self support of training sorties. Red Air sorties are typically low in their training value but are a necessary requirement of an air-to-air squadron that must, for effective training, fly against live targets.

RAND interviewed 17 Instructor Pilots and Flight Leads in the 388th Fighter Wing at Hill AFB, Utah and asked them to quantify the number of monthly sorties a pilot should fly to be ready to immediately enter combat. The preponderance of responses and the average were both 13. Thus, the RAND model is constructed to try to get pilots as close to 13 sorties per month as possible (7).

After the model was verified and validated, they performed a linear regression on each of the models and created metamodels for each weapon system that do not require special analysis software to execute. The following list is a summary of the RAND meta-model for the F-15C.

<u>Explanation of variables</u>

N(InexpWing) = Number of inexperienced wingmen ($N_{'NWG'}$)

N(ExpWing) = Number of experienced wingmen ($N_{'XWG'}$)

N(FL_IP) = Number of flight leads and IPs ($N_{'NF2'}+N_{'NF4'}+N_{'XF2'}+N_{'XF4'}+N_{'XIP'}$)

N(BMC) = Number of BMC pilots ($N_{'BMC'}$)

S(InexpWing) = Total sorties by inexperienced wingmen

S(ExpWing) = Total sorties by experienced wingmen

S(FL_IP) = Total sorties by flight leads and IPs

S(BMC) = Total sorties by BMC pilots

S(MQT) = Total sorties by pilots in MQT

S(RC) = Rear cockpit IP sorties

The RAND Meta-Model

S(InexpWing) = 12.94275 x N(InexpWing)

S(ExpWing) = 11.81205 x N(InexpWing)

S(BMC) = 10.41564 x N(BMC)

S(MQT) = 10.83333

S(RC) = 4.16667

S(FL_IP) = Max [(12.43971 x N(FL_IP), (0.11004 x N(FL_IP) + S(InexpWing) + S(ExpWing) + S(BMC) + S(MQT) – S(RC))]

The RAND corporation performed multiple comparison runs for both 18 PAA and 24 PAA squadrons, with identical data for the full scale model and the meta-model. The largest difference they found was just over 1%, which verified the validity of the meta-model (7).

The RAND model generates a flying hour program that is considerably larger than the RAP model. Although biased towards their own work, the RAND corporation noted this fact in a 2002 strategic appraisal of United States Air and Space Power in the 21st Century. In that report, Dahlman and Thaler list three major limitations to the RAP model.

First, “the RAP model does not account for changes in individual and unit sortie requirements when the experience mix in the unit changes” (10). The more inexperienced pilots a squadron has, the more the experienced pilots and instructor pilots must fly to ensure the inexperienced pilot’s safety. This increases the total number of sorties for the unit.

Second, “RAP is constrained by shortfalls in unit maintenance resources” (10). Because RAP uses the squadron’s UTE rate to help figure out how many sorties are available, Dahlman and Thaler argue that the true training sortie requirements are masked. Maintenance can only produce a certain number of sorties, ACC funds based on that recommendation, and the pilots’ training is negatively impacted.

Third, “the attrition rate RAP assumes significantly underestimates observed rates at many wings” (10). In other words, RAP is overly optimistic. As the F-15C continues to age, the availability of sorties will steadily decrease.

Not only is the RAP model insufficient for training, but Air Force is still concerned that it is spending too much money on F-15C flying. This research uncovered Air Staff concerns that an excessive number of BFM sorties were being flown due to program inefficiencies. A review of audits performed by the Air Force Audit Agency within the past 2 years indicates that F-15C squadrons achieve results that are effective given imposed constraints, via aggressive scheduling policies. However, the squadrons find it almost impossible to meet all the RAP and non-RAP requirements given current flying hour funding levels.

The excessive number of BFM sorties is a result of the fluid tactical flying environment. When a sortie is launched with specific objectives in mind, it is not always completed as planned. Sorties involving multiple aircraft introduce higher probabilities of maintenance issues and a greater need for large, weather-free airspace. This results in more sorties being modified as contingencies occur. Pilots brief back-up missions to fly if their primary mission is unattainable. BFM is the simplest mission available that still results in good tactical training. As it only involves 2 aircraft, it is often the fall-back mission for sorties that can not be executed as planned. Thus, at the end of the year, an F-15C squadron typically has flown far more BFM than is required by the RAP program as a fluid response to obstacles which prevent completion of the original mission.

Unfortunately, as fiscal resources have become more constrained, funding just enough flying hours to accomplish the minimum has become the norm. The result is that fighter squadrons are struggling to accomplish the minimum requirements to meet annual RAP requirements. For example, an Air Force Audit Agency audit conducted of the F-15C flying hour program at Mountain Home AFB, ID, in 2005 revealed that the squadron was 33 sorties short of the RAP minimum sortie requirements at the end of the year (6). In the report, the Operations Officer of the F-15C fighter squadron stated that the reason his squadron was unable to finish the RAP requirements was that the squadron started preparing for a four month deployment “6 weeks prior to the departure date and during this time, training was not a priority” (6).

The Operations Officer’s comment illustrates two crucial points. First, the squadron’s flying schedule is so tightly constrained that even a small perturbation in the flow can cause unrecoverable deficits. Squadrons encounter situations weekly that cause schedule changes or flight cancellations. Weather, unexpected maintenance inspections, or inputs from headquarters can cause squadrons to lose sorties that are impossible to make-up. It is clear from his squadron's experience and the squadrons examined in the other audits of F-15C units that current flying hour funding levels are insufficient to give the squadron the required flexibility to have anything other than an impossible to achieve perfect flying schedule.

The second point made by the Operations Officer is that the squadron, while executing the RAP program, was not ready to go war. The squadron had to spend 6 weeks concentrating on combat tactics, flying extra sorties, and making sure all pilots were current on all needed events. According to the RAND model, flying 13 sorties per month would do away with the need for a squadron pre-combat spin-up program. The squadron would be ready to deploy to a combat location immediately. Thus, the training program can continue up to departure time, ensuring valuable upgrade sorties are not lost and continuing the advancement of pilot skills.

This paper will attempt to verify the claim that the RAND model generates flying hour program models with significantly more recommended sorties. Additionally, this paper will attempt to modify the RAP model to increase the number of sorties it generates for flying hour programs to a level commensurate with the results from the 1998 Air Force Safety Center report sorties per month.

III. Methodology

This chapter reviews the data gathered from operational F-15C fighter squadrons and the spreadsheets created to calculate the flying hour program recommendations for both the RAND and the RAP models. After performing a statistical comparison of the pairs of results for each squadron, recommendations will be made towards improving the RAP model.

Operational F-15C squadrons have found it difficult to meet RAP and non-RAP flying requirements given the fiscally constrained number of flying hours available. Even more concerning are proposed future reductions in flying hours, without any corresponding reduction in requirements.

The first focus of this research was to determine the number of additional sorties that need to be distributed to the fighter squadrons annually to achieve appropriate levels of combat readiness. RAP was never meant to be the total number of sorties for a year. It was set up to be an absolute minimum number of sorties for a pilot to be tactically viable.

To continue to investigate the issue, a comparison study between the RAND model and the RAP model was performed to discover the differences and determine if ACC truly was delivering too few flying hours in order for the fighter squadrons to have an effective training program.

Each of the F-15C fighter squadrons was contacted and a copy of their Letter of X's (LOX's) requested. The example LOX in appendix A has the pilots' names and jobs removed for anonymity. 6 responses were received out of 9 operational squadrons. From these LOX's, the make-up of the fighter squadrons was determined in terms of number and qualification of pilots. This resulted in 6 data sets with which analysis and comparison could be performed. The RAND model came up with the base case to test the validity of their model. The base case allowed comparison of identical numbers for the input to the different sets of output.

The next step was to review the assumptions behind both models to determine if they were still accurate. The RAP model is very current, as ACC uses it on a regular basis for the flying hour program. ACC/A3TO is constantly updating the spreadsheet as new regulations are published and sortie requirements for RAP cycles change. The only real assumption made in the process of constructing a RAP model is the cost of business percentage. That percentage is variable as different squadrons have unique operating environments. For example, some squadrons may support more air shows while other squadrons may use a lot of sorties taking their aircraft to depot level maintenance facilities. As previously stated in Chapter 2, ACC/A3TO recommends using 20% as an average COB level (15).

The RAND model has several assumptions, some of which were out of date because the model was developed 3 years ago. For example, the annual number of non-RAP sorties required by AFI 11-2F-15V1 changed to require 13 night sorties for inexperienced pilots and 12 night sorties for experienced pilots whereas the RAND model is programmed for 4 night sorties (13 and 7). The RAND model does not add in any cost of business sorties. Thus, for a true comparison, the end result of the RAND model must be multiplied by 1.08 for an accurate COB level. The 8% is a recommendation stated within the RAND report. It differs from the 20% COB factor recommended by ACC because RAND incorporates some of the COB sorties into their model. This drives the two models even further apart in their recommendations.

Once the limitations were reviewed, the next step was to create a spreadsheet for the RAND meta-model and copy the RAP spreadsheet. An example of the RAND meta-model spreadsheet can be seen in Appendix C and a copy of a RAP spreadsheet can be seen in Appendix D. The results were linked to a spreadsheet that would allow comparison of all the inputs and the outputs on one page (Table 6).

Table 6. RAND/RAP Annual Flying Hour Comparison Spreadsheet

Squadron	RAP	RAND	Difference	% Difference
A	5,440	7713.95	2273.63	141.79%
B	6,993	9855.49	2862.85	140.94%
C	6,863	9767.52	2904.48	142.32%
D	8,721	9512.00	791.36	109.07%
E	5,748	7833.51	2085.03	136.27%
F	5,887	8291.49	2404.77	140.85%
		Total	13322.11	811.25%
		Average	2220.35	135.21%

The RAND F-15C base case was used first to investigate the differences between the two models. The results of the RAND study base case were replicated, thus validating the RAND meta-model. Then the data from the six F-15C operational squadrons was input into the RAP model and the results were compared.

The next step was to compare the results of the data sets to identify the differences. The RAP model breaks down the recommendations based on number of sorties needed for each pilot category like the RAND model does. Thus, the number of sorties per month for each type of pilot (API-1 exp/inexp, API-6 exp/inexp) could be compared directly. Additionally, the overall average number of sorties could be compared.

The RAND model numbers for each pilot category change as the experience level in the squadron changes. The lower the experience level is in the squadron, the more sorties the experienced flight leads and Instructor Pilots must fly.

Once statistical comparisons were completed, the RAND model input values were manipulated to determine the change to the annual sortie requirements necessary to result in increased numbers of sorties per month. A linear model was created using the Jensen Solver Excel add-in (20). The objective function involved minimizing the number of required sorties per pilot per year. The constraints mimicked the internal calculations of the RAP spreadsheet and can be seen in Appendix E.

To keep sortie ratios constant, constraints were generated that required experienced API-1 sorties to be at a level of at least 89% of the inexperienced API-1 sorties. Additionally, BMC experienced sorties were kept at a level at least 54% of inexperienced API-1 sorties. The percentages were obtained by using the current annual sortie requirements in AFI 11-2F-15V1 (13). Setting the number of sorties to AFI levels in the linear model replicated the results obtained using the RAP spreadsheet, thus validating the linear model (Appendix F).

The number of sortie additions was optimized to generate at least 11 sorties per month for API-1 experienced and inexperienced pilots. The number of sorties for attached API-6 and API-8 pilots were kept at current levels. The rationale behind this was that the line combat pilots (API-1) need to be the most proficient as they would be the first deployed in a contingency situation. Annual sortie requirements for the 13 sorties per month RAND recommendation were also investigated.

The number of additions required to raise RAP sortie per month, detailed in Chapter 5, becomes a recommendation to Air Staff for a change to AFI 11-2F-15CV1. One can also multiply those increases in sorties by an ASD to get a total number of hours required and multiply that by the cost per flying hour to determine the increase in monetary expenditures for one squadron. There are approximately 12 F-15C fighter squadrons worldwide, so one could also determine the increase for the F-15C community as a whole.

IV. Results and Analysis

Base Case Model

In order to show validity for their F-15C model, the RAND corporation performed a trial run using an F-15C squadron with 18 PAA. With the pilot-to-aircraft ratio of 1.25, the squadron had 23 API-1 CMR pilots. The squadron commander and operations officer were CMR API-6 pilots (flying API-1 sortie rates) along with 4 other BMC API-6 pilots. The experience level was calculated to be 65.2% experienced and the model was calibrated to "produce a requirement of about 13 sorties per month for inexperienced wingmen, and a little fewer than that for experienced pilots" (7).

The breakdown of the pilot numbers for the base case is shown in Table 7 below. The total number of pilots in the base case squadron was 29.

Table 7. Base Case Breakdown of Numbers

Category	Number
Inexperienced Wingman	7
Experienced Wingman	1
Inexperienced Flight Lead	1
Experienced Flight Lead	7
Instructor Pilot	9
BMQ (Attach API-6)	4
PMAI	18

The complete RAND linear model produced a requirement for 365.86 sorties per month, or 4,390.32 sorties per year. This equated to 12.62 sorties per pilot per month on average. Given an average ASD of 1.2, the total number of flying hours for the year would be 5,269. Increasing the annual flying hour requirement by 8% for cost of business sorties drives the number to 5,690 (7). The RAND F-15C meta-model produced very similar numbers and can be seen in Appendix C.

Using the same squadron make-up as the RAND model base case, the RAP model recommended a total of 4,262 hours (3,551.67 sorties) for the year (See Appendix D). This equated to 10.2 sorties per month per pilot on average. This was a difference of 1,428 hours, or 75% of the RAND recommendation (Table 8).

Table 8. RAND/RAP Base Case Comparison

Category	**RAND**	**RAP**
Hours per year	5,690	4,262
Sorties per year	4,741	3,551.67
Sorties per month	13.62	10.2

Utilizing the created sortie optimization linear model, optimal sortie mixes were generated that minimize the number of annual sorties required while still allowing for the desired number of sorties per month. Table 9 summarizes the results of the 11 and 13 sortie per month models for the base case squadron. Total cost for the entire F-15C community, given 12 squadrons, would be $14,016,348 and $59,734,908 for the 11 and 13 sortie per month solutions, respectively.

Table 9. Results Using Sortie Optimization Linear Model with Base Case

Category	AFI 11-2F-15V1	11 sorties/month	13 sorties/month
CMR EXP	98	104	125
CMR INEX	110	117	140
BMC EXP	60	60	60
BMC INEX	72	72	72
API-8	60	60	60
Increase in annual sortie requirements		13	57
Squadron annual flying hours	4,262	4,490	5,269
Cost increase for 1 squadron ($5,013/hr)		$1,142,964	$5,048,091
UTE	16.44	17.32	20.33
A/C to bring UTE back to original level		+1 (19)	+4 (22)

The following series of tables summarizes the results of the optimizations for each of the 6 operational squadrons. The "increase in annual sortie requirements" row is simply a sum of the additional sorties above current levels already established in AFI 11-2F-15V1. The UTE row displays the approximate UTE for that squadron for each of the three conditions. "A/C to bring UTE back to original level" displays the increase in owned aircraft that a squadron must have to return their UTE to the levels prescribed by sortie rates established in AFI 11-2F-15V1.

Table 10. Squadron A Results

Category	AFI 11-2F-15V1	11 sorties/month	13 sorties/month
CMR EXP	98	104	125
CMR INEX	110	117	140
BMC EXP	60	60	60
BMC INEX	72	72	72
API-8	60	60	60
Increase in annual sortie requirements		13	57
Squadron annual flying hours	5,440	5,711	6,648
Cost increase for 1 squadron ($5,013/hr)		$1,358,523	$6,055,704
UTE	20.99	22.03	25.65
A/C to bring UTE back to original level		+1 (19)	+4 (22)

Table 11. Squadron B Results

Category	AFI 11-2F-15V1	11 sorties/month	13 sorties/month
CMR EXP	98	104	124
CMR INEX	110	117	140
BMC EXP	60	60	60
BMC INEX	72	72	72
API-8	60	60	60
Increase in annual sortie requirements		13	56
Squadron annual flying hours	6,993	7,358	8,571
Cost increase for 1 squadron ($5,013/hr)		$1,829,745	$7,910,514
UTE	20.23	21.29	24.8
A/C to bring UTE back to original level		+1 (25)	+5 (29)

Table 12. Squadron C Results

Category	AFI 11-2F-15V1	11 sorties/month	13 sorties/month
CMR EXP	98	105	125
CMR INEX	110	118	141
BMC EXP	60	60	60
BMC INEX	72	72	72
API-8	60	60	60
Increase in annual sortie requirements		15	58
Squadron annual flying hours	6,863	7,259	8,394
Cost increase for 1 squadron ($5,013/hr)		$1,985,148	$7,674,903
UTE	20.72	21.92	25.65
A/C to bring UTE back to original level		+1 (24)	+5 (28)

Table 13. Squadron D Results

Category	AFI 11-2F-15V1	11 sorties/month	13 sorties/month
CMR EXP	98	104	124
CMR INEX	110	117	140
BMC EXP	60	60	60
BMC INEX	72	72	72
API-8	60	60	60
Increase in annual sortie requirements		13	56
Squadron annual flying hours	8,721	9,180	10,699
Cost increase for 1 squadron ($5,013/hr)		$2,300,967	$9,915,714
UTE	12.62	13.28	15.48
A/C to bring UTE back to original level		+2 (50)	+11 (59)

Table 14. Squadron E Results

Category	AFI 11-2F-15V1	11 sorties/month	13 sorties/month
CMR EXP	98	103	123
CMR INEX	110	116	138
BMC EXP	60	60	60
BMC INEX	72	72	72
API-8	60	60	60
Increase in annual sortie requirements		11	53
Squadron annual flying hours	5,748	6,016	7,042
Cost increase for 1 squadron ($5,013/hr)		$1,343,484	$6,486,822
UTE	16.63	17.41	20.38
A/C to bring UTE back to original level		+1 (25)	+5 (29)

Table 15. Squadron F Results

Category	AFI 11-2F-15V1	11 sorties/month	13 sorties/month
CMR EXP	98	105	125
CMR INEX	110	118	140
BMC EXP	60	60	60
BMC INEX	72	72	72
API-8	60	60	60
Increase in annual sortie requirements		15	57
Squadron annual flying hours	5,887	6,248	7,265
Cost increase for 1 squadron ($5,013/hr)		$1,809,693	$6,907,914
UTE	20.44	21.70	25.23
A/C to bring UTE back to original level		+1 (21)	+5 (29)

Table 16. Summary Statistics of the 6 Operational Squadrons

	11 (Average)	11 (Std Dev)	13 (Average)	13 (Std Dev)
CMR EXP	104	0.753	124	0.82
CMR INEXP	117	0.753	140	0.98
Increase in annual pilot requirements	13.3	1.5	56.2	1.72
Increase to flying hour program	353	73.5	1495	274.9
Cost	$1,771,260.00	$370,021.43	$7,491,928.00	$1,378,222.22
UTE	19.5	3.56	22.9	4.14
Number of additional aircraft required	1.2	0.41	5.8	2.56

V. Conclusions and Recommendations

The initial thrust of the research was to compare the two models and determine which one was more effective. However, to have an accurate comparison, the two items being compared need to be designed for the same purpose. The RAND model and the RAP model are constructed with two completely different mind sets.

The RAND model strives to generate a flying hour program recommendation which includes enough sorties that a squadron would have no need for a spin-up program in the event it was called into immediate combat. The RAND corporation determined that 13 sorties per month per pilot would build a fighter pilot who is always ready for combat. This number was the response from veteran fighter pilots and fighter squadron leadership, who can be considered “expert witnesses” in the art of aerial combat.

In contrast, the RAP model is designed to build a flying hour program recommendation that provides just enough sorties to meet the minimum annual sortie counts for the fighter pilots. The result is an average of 8-10 sorties per month per pilot, far below the level desired by combat leaders.

Unfortunately, increasing sortie counts for pilots is not as simplistic as just making the decision to do it. The fiscal outlay for increasing sortie rates can be prohibitive. The average result obtained using the six operational F-15C squadrons with the sortie optimization linear model indicate an average increase in annual sorties of 1,245.8 to reach the level of 13 sorties per pilot per month. Multiplying this number by the logistical cost per flying hour for the F-15C results in a squadron bill of $7,491,928 million and $67,427,352.00 for the entire F-15C community of 9 operational squadrons. This cost is just for logistical outlays accrued in flying the F-15C. It does not include additional costs in manpower and infrastructure that would come with increased aircraft on the ramp. Although this may seem expensive, it pales in comparison to the $160 million per copy spent on the F/A-22.

As a financial compromise, ACC could increase the number of annual sorties for CMR experienced pilots by 6 and CMR inexperienced pilots by 7 to bring the monthly sortie totals up to at least 11, as recommended by the Air Force Safety Center. Using the results from the sortie optimization linear model, the logistical cost incurred implementing this solution would be approximately $1,771,260 per squadron and $15,941,340 for the entire F-15C community. Increasing the average sorties per month gives a squadron approximately 200 more sorties. Looking back at Chapter 2 at the audit from the F-15C squadron at Mountain Home AFB, these 200 extra sorties would be more than enough for them to complete RAP sortie requirements and dramatically increase combat readiness.

The increase in the requirements for pilot sorties per month affects another critical part of a fighter squadron. If the squadron receives no additional aircraft with which to fly the additional sorties, the UTE rate of the possessed aircraft increases. UTE rates for squadrons were manipulated by changing the annual sortie requirements using the RAP spreadsheet while holding the PMAI number constant. Increasing the monthly sorties per pilot to 11 drives the UTE rate up an average of 1.0. For example, the base case scenario UTE increases from 16.44 to 17.32. That translates to each aircraft owned by the squadron flying approximately one more time per month. Even though this is only a 5% increase in UTE rate, the culture of most maintenance organizations is such that any increase in UTE will be rebuffed. They contend that increasing the UTE rate, the break rate (the rate at which aircraft break) will increase. However, current work at the Air Force Institute of Technology indicates that the break rate will stay constant as the UTE increases. In fact, their linear regression model shows statistically that “the more the aircraft are flown, the higher the Mission Capable rate” (23).

The other avenue through which to attack this problem is to increase the number of aircraft assigned to each squadron to offset the increased UTE that comes from increasing monthly sortie requirements. The RAP spreadsheet was used to determine the number of aircraft needed to reduce the UTE rate back to pre-sortie increase rates. This was accomplished by freezing the number of pilots in the squadron and varying the PMAI numbers. The results indicate that to increase the monthly sortie count per pilot to 11, each squadron would have to receive, on average, 1.2 aircraft.

Although this is only a 6.7% increase, the fiscal effects are far more dramatic. Unfortunately, the Air Force does not have a reserve of aircraft to draw from. The active duty Air Force currently has approximately 250 F-15Cs and each one is assigned to a squadron (17). As the F-15C force is drawn down, squadrons close and their aircraft are shifted to other squadrons, the Air National Guard, and eventually to the bone yard. It is possible, though unlikely, that some of these cascading aircraft transfers could be redirected to increase the PMAI in each squadron to allow for higher monthly sortie counts per pilot.

It is the recommendation of this research that ACC increase the number of annual sorties per CMR experienced pilot from 98 to 104 and per CMR inexperienced pilot from 110 to 117. These changes will result in 11 sorties per month per pilot on average. This recommendation is made in preference to the RAND ideal of 13 sorties per month due to the fiscal realities of operating a combat air force in a world environment in which the F-15C air superiority fighter has limited utility. Additionally, flying at a rate of 11 versus 13 sorties per month results in a bill that is $51,486,012.00 less.

By implementing this change to AFI 11-2F-15V1, ACC will allow squadron leadership the flexibility to successfully complete the minimum RAP requirements while making greater strides towards being better combat readiness. The increased number of monthly sorties will improve fighter pilot proficiency and currency. Additionally, more sorties means younger fighter pilots have the opportunity to gain experience faster, allowing the fighter squadrons to more easily maintain the necessary balance of experienced vs. inexperienced pilots. Ultimately, this may have the 2nd order effect of decreasing combat losses and decreasing aircraft mishap rates.

This research should not be the last in this area of study. This problem warrants further investigation into the metrics that should be tracked to gauge fighter squadron readiness. Armed with that information, a pilot study could be initiated in which ACC funds one squadron at the 11 sorties per month rate and then accomplishes a comparison study to see if there is any statistically significant improvement. Another study could be done to track the number of sorties flown above the RAP minimums and determine, using the above mentioned metrics, the correct levels of required sorties to optimize combat readiness.

List of Terms

This Graduate Research Project is replete with terminology specific to the fighter aviation community. In order to simplify the reading, all the terms have been grouped into one location. The reader should be familiar with these terms before proceeding to the main paper. Most of these definitions were obtained from attachment 2 of Air Force Instruction 11-2F-15V1.

Air Combat Maneuvering (ACM) – Training designed to achieve proficiency in element formation maneuvering and the coordinated application of BFM to achieve a simulated kill or effectively defend against one or more aircraft from a pre-planned starting position (2 vs. 1).

Air Combat Tactics (ACT) – Training in the application of BFM, ACM, and tactical intercept skills to achieve a tactical air-to-air objective (multiple vs. multiple).

Aircraft Handling Characteristics (AHC) – Basic skills sortie. Training for proficiency in utilization and exploitation of the aircraft flight envelope, consistent with operational and safety constraints, including, but not limited to high/maximum angle of attack maneuvering, energy management, minimum time turns, maximum/optimum acceleration and deceleration techniques, and confidence maneuvers.

Air Refueling (AAR) – An AAR event requires tanker rendezvous, hook-up and transfer of fuel or 2 minutes of dry contact.

Attrition Sortie – A sortie planned and launched as a RAP training sortie, Non-RAP sortie, or collateral sorite, that, due to some circumstance (weather, emergency, maintenance, etc.), fails to accomplish the planned mission.

Basic Aircraft Qualification (BAQ) – A status of an aircrew member who has satisfactorily completed training prescribed to maintain the skills necessary to fly the unit aircraft.

Basic Fighter Maneuvers (BFM) – Training designed to apply aircraft handling skills to gain proficiency in recognizing and solving range, closure, aspect, angle off, and turning room problems in relation to another aircraft to either attain a position from which weapons may be launched, or defeat weapons employed by an adversary (1 vs. 1).

Basic Mission Capable (BMC) – The status of an aircrew who has satisfactorily completed training prescribed to be fully qualified to perform the basic unit operational missions but does not maintain combat mission ready status. Aircrew accomplishes training required to remain familiarized in all, and may be qualified and proficient in some, of the core missions of their weapon system and unit.

Collateral Sorties – Sorties not directly related to combat employment or basic skills training but necessary for accomplishment of unit missions. These include ferry flights, deployments, FCF flights, incentive flights, orientation flights, air shows, etc. These sorties are not required for RAP training purposes.

Combat Mission Ready (CMR) – A status of an aircrew member who has satisfactorily completed training prescribed to be fully qualified to perform the basic unit operational missions, and maintains qualification and proficiency in these missions.

Contingency Sortie – A mission tasked and flown while deployed for a contingency operation in which training is limited. These sorties do not count towards annual RAP requirements.

Continuation Training (CT) – Training to maintain proficiency and improved aircrew capabilities to perform unit missions and aircrew proficiency sorties not flown in formal syllabus missions, tests, or evaluations.

Currency – The minimum frequency required to perform an event or sortie safely.

Defensive Counter Air (DCA) – Mission sortie designed to develop proficiency in DCA mission tactics. Mission elements included: Intel scenario and mission planning, execution of tactics to detect, engage, and negate aircraft employing adversary tactics and weapons capabilities to penetrate protected airspace.

Demanding Sortie – Sorties that task the pilot to the extent that flying frequency and continuity are most critical. These include ACM, ACT, LOWAT.

Flight Lead (FL) – As designated on flight orders, the individual responsible for overall conduct of mission from preflight preparation/briefing to post flight debriefing, regardless of actual position within the formation. This category can be further broken into 2-ship FL and 4-ship FL.

Initial Qualification Training (IQT) – Initial training for a pilot in a specific type of aircraft. F-15C IQT lasts for just over 6 months and involves 43 sorties.

Instructor Pilot (IP) – A pilot with a qualification to perform instructor duties during flight.

Instrument Sortie – Basic skills sortie. Training designed to ensure instrument proficiency. RAP events may be accomplished on an instrument sortie provided accomplishment does not interfere with the primary goal of instrument training.

Low Altitude Training (LOWAT) – Operations in a certified low altitude block (generally less than 5,000’ above the ground). LOWAT includes low altitude navigation, tactical formation, defensive maneuvering to avoid or negate threats, skills necessary to search for and offensively engage an aerial target at low altitude, and air-to-surface attacks.

Mission Qualification Training (MQT) – Training received in an operational unit once a pilot completes IQT. The pilot is not allowed into combat situations until completing MQT satisfactorily.

Night Sortie – Sortie on which either takeoff or landing and at least 50 percent of flight duration or 1 hour, whichever is less, occur between the period of official sunset ot official sunrise.

Offensive Counter Air (OCA) – Mission sortie designed to develop proficiency in OCA mission tactics. Mission elements included: Intel scenario and mission planning, execution of tactics to detect, engage, and negate aircraft employing adversary tactics and weapons capabilities to penetrate enemy airspace. Also includes protecting strike assets and escorting other aircraft on interdiction missions.

Primary Aircraft Assigned for Wartime Mission (PMAI) – The number of aircraft a squadron is assigned to accomplish their wartime mission tasking.

Ready Aircrew Program (RAP) – The continuation training program designed to focus training on capabilities needed to accomplish a unit's core tasked missions.

Tactical Intercept (TI) – A single-ship or multi-ship intercept performed to accomplish the tactical objective (identify or kill the threat) in a realistic threat scenario.

Appendix A: Sample F-15C Squadron Letter of X's

API	TNG	EXP	WXCT	2SH	4SH	MCC	IPF	NVG	BANR	TOP3	SOF	SEF	FCF
1	CMR	E	1	X	X	X	X	IP	IP	X		X	
1	CMR	E	1	X	X	X	X	IP	IP	X	I	X	
1	CMR	E	1	X	X	X	X	IP	IP	X	I	X	X
1	CMR	E	1	X				FL	FL	X			
1	CMR	E	1	X	X			FL	FL	X	X		
1	CMR	E	2	X	T	T	T	WG	WG	X			T
1	CMR	E	1	X	X	X	X	IP	IP		T		
[redacted]													
1	CMR	E	2	X	X	X		FL	FL		I		
1	CMR	N	3					WG	WG				
1	MQT	E	2										
1	MQT	N	4										
1	CMR	N	3	T				WG	WG				
1	MQT	E	3										
6	CMR	E	1	X	X	X	X	IP	IP		I	X	
1	CMR	E	3	X				WG	WG				
6	BMC	E	1	X	X	X	X	IP	IP			X	
6	BMC	E	2	X	X	X	X	IP	WG		I		T
8	BMC	E	1	X	X	X	X	IP					
1	CMR	E	2	X	T			FL	FL				
6	CMR	E	1	X	X	X	X	IP	IP		X		
6	CMR	E	1	X	X	X	X	IP	IP		I	X	
6	CMR	E	2	X	X			FL	FL		X		
6	BMC	E	1	T	T		T	WG					
6	BMC	E	1	X	X	X	X	IP					
1	BMC	E	1	X	X			FL	FL		X		
1	CMR	E	2	X	X			FL	WG		T		
6	BMC	E	1	X	X	X		FL	FL		I		
8	BMC	E	1	X	X	X	X	IP					

Appendix B: RAND Model

DEFINITIONS

j = Job (inexperienced wingman, instructor pilot, etc)

p = Profile (BFM, ACM, ACT, etc)

v = Version (flag exercise, dissimilar)

s = Skill

Y_{jpv} = Number of sorties of profile p and version v flown by crew members in job j

$Sprac_{spv}$ = Number of units of skills that a crew member in job j must accumulate during each training period (i.e. the demand for skill units per pilot per period).

OBJECTIVE FUNCTION

$Min\_z = \sum_{j,p,v} Yjpv$ (minimize the number of sorties)

Jobs for F-15C pilots

Pilot Category	Job
Pilots in MQT	NMQ
Inexperienced wingmen	NWG
Experienced wingmen	XWG
Inexperienced 2-ship FL	NF2
Inexperienced 4-ship FL	NF4
Experienced 2-ship FL	XF2
Experienced 4-ship FL	XF4
Instructor pilot	XIP
Basic Mission Capable	BMC

Subsets of jobs

WG = {NWG, XWG}

FL = {NF2, NF4, XF2, XF4}

IP = {XIP}

Sortie profiles and versions

NIGHT = {NAIR, NINS, NROT, NIPR, NAOR}

SUP = {TINT, OCA, DCA, BFM, ACM, NAIR, AOR, NAOR}

Sortie versions in the F-15C model

Version	Description
B	Basic, flown at home station
FLG	Flag, an exercise away from home station
CFX	Composite force exercise
DIS	Flown against dissimilar aircraft
IP	Flown by an IP grading an upgrade sortie
RA	Red Air

Legitimate profile-version-job combinations in the F-15C model

Profiles	Version	Permitted Job
All except PR, NIPR	B	All
PR, NIPR	B	XIP
All	FLG, CFX, DIS, RA	All except NMQ
All except PR, NIPR	IP	XIP

CONSTRAINTS

Skill Acquisition and Practice

$$\sum_{p,v} Sprac_{spv} * Y_{jpv} \geq Dprac_{sj} * N_j \quad \forall s,\ j \neq NMQ \tag{2.2}$$

Air Force Mandates

Each pilot must fly at least one AHC sortie, two instrument sorties, and two night sorties per 6 month training period. Number of AHC sorties must be equal to or greater than number of Night sorties for everyone not in MQT:

$$Y_{j,'AHC','B'} \geq N_j \quad \forall j \neq NMQ \tag{2.3}$$

Number of instrument sorties must be equal to or greater than 2 times the number of night sorties for everyone not in MQT:

$$Y_{j,'INS','B'} \geq 2N_j \quad \forall j \neq NMQ \tag{2.4}$$

Two night sorties per 6 month training period:

$$\sum_{p,v \in Night} Y_{jpv} \geq 2Nj \quad \forall j \neq NMQ \tag{2.5}$$

Demanding mission currency: The model first specifies the set of correspondences between nighttime and daylight profiles (pairs are night/day):

NIGHT2DAY = {(NAIR,OCA),(NAIR,DCA),(NAIR,TINT),(NINS,INS), (NROT,ROT), (NIPR,IPR), (NAOR,AOR)}

DAY(p) = {pp $\left|(p, pp) \in NIGHT2DAY\right.$}

Then sets the constraint for night requiring day:

$$\sum_{v} Y_{jpv} \geq \sum_{pp \in DAY(p),v} Y_{j,pp,v} \quad \forall j \neq NMQ, p \in NIGHT \tag{2.8}$$

At most, ¾ of all sorties can be flown at night:

$$\sum_{j,p \in NIGHT,v} Y_{jpv} \leq 0.75 * z \tag{2.10}$$

Of each pilot category's total BFM and ACM sorties, at least 25 percent must be BFM sorties:

$$\sum_{v} Y_{j,'BFM',v} \geq 0.25 * \sum_{v} (Y_{j,'BFM',v} + Y_{j,'ACM',v}) \quad \forall j \neq NMQ \tag{2.12}$$

Of each pilot category's total ACM and ACT sorties, at least 25 percent must be ACM sorties:

$$\sum_{v} Y_{j,'ACM',v} \geq 0.25 * \sum_{v} (Y_{j,'ACM',v} + Y_{j,'OCA',v} + Y_{j,'DCA',v}) \quad \forall j \neq NMQ \tag{2.13}$$

Availability and distribution of enhanced sorties: During a training period, a squadron can fly no more than 90 sorties at flag exercises, 180 sorties at composite force exercises, and 180 sorties against dissimilar aircraft:

$$\sum_{j,p} Y_{jpv} \leq XColLim_v \quad \forall v \tag{2.14}$$

Wingmen are prohibited from flying more than their "fair share" of enhanced sorties:

$$\sum_{p} Y_{jpv} \leq \left(\frac{Nj}{\sum_{jj \in CMR} Njj} \right) * XColLim_v \quad \forall j \in WG, v \tag{2.15}$$

Definition of Variables for Upgrades

u = Upgrade index

$Upgd_u$ = Number of upgrades of type u.

$UGAllocpu$ = Indicator of which pilots are eligible for upgrades (1 if pilot type j can fly upgrade type u)

$IPSort_{pu}$ = Number of profile p sorties in the syllabus for upgrade type u

$FCIPSotr_{pu}$ = Number of profile p sorties in the syllabus for upgrade type u for which the supervising IP flies in the front cockpit

Number of upgrade sorties of profile p flown by upgrading pilots in class j:

$$\mathrm{UGSort}_{\mathrm{jp}} = \sum_{u} \left(IPSort_{pu} * Upgd_u * \frac{UGAlloc_{ju} * N_j}{\sum_{jj} UGAlloc_{jj,u} * N_{jj}} \right) \quad \forall j, p \tag{2.16}$$

To ensure all upgrade sorties will be flown:

$$Y_{jp,'B'} \geq UGSort_{jp} \quad \forall j, p \tag{2.17}$$

IP front cockpit sorties that go with the upgrade sorties:

$$\sum_{j \in IP} Y_{jp,'IP'} \geq \sum_{u} FCIPSort_{pu} * Upgd_u \quad \forall p \tag{2.18}$$

Forces each IP to fly approximately his share of front cockpit upgrade sorties:

$$\sum_{p} Y_{jp,'IP'} \geq \left(\frac{N_j}{\sum_{jj \in IP} N_{jj}} \right) * \sum_{jj \in IP, p} Y_{jj,\, p,'IP'} - 0.1 * N_j \quad \forall j \in IP \tag{2.21}$$

Number of rear cockpit IP sorties:

$$RCIPSort_{pu} = IPSort_{pu} - FCIPSort_{pu} \quad \forall p,u \tag{2.22}$$

Number of day rear cockpit IP sorties:

$$\sum_{j \in IP} Y_{j,'IPR','B'} \geq \sum_{u, p \notin NIGHT} RCIPSort_{pu} * Upgd_u \tag{2.23}$$

Number of night rear cockpit IP sorties:

$$\sum_{j \in IP} Y_{j,'NIPR','B'} \geq \sum_{u, p \in NIGHT} RCIPSort_{pu} * Upgd_u \tag{2.24}$$

Forces each type of IP to fly his share of rear cockpit day sorties:

$$Y_{j,'IPR','B'} \geq \left(\frac{N_j}{\sum_{jj \in IP} N_{jj}} \right) * \sum_{jj \in IP} Y_{jj,'IPR','B'} - 0.25 * N_j \quad \forall j \in IP \tag{2.26}$$

Forces each type of IP to fly his share of rear cockpit night sorties:

$$Y_{j,'NIPR','B'} \geq \left(\frac{N_j}{\sum_{jj \in IP} N_{jj}} \right) * \sum_{jj \in IP} Y_{jj,'NIPR','B'} - 0.25 * N_j \quad \forall j \in IP \tag{2.27}$$

Red Air Sorties

For every OCA, DCA, or ACM sortie by an upgradee, there will be two Red Air sorties of the same profile. The upgradee will be in a flight of two or four aircraft, which will be opposed by two aircraft playing the role of red air:

$$YRA_p = \sum_u Upgd_u * \left(IPSort_{pu} + FCIPSort_{pu}\right) \quad p \in \{OCA, DCA, ACM\}$$

Requirement for inflight supervision:

$$\sum_{j \neq 'NMQ'} Y_{j,\, p,\, 'RA'} = YRA_p \quad p \in \{OCA, DCA, ACM\} \tag{C.N1}$$

Inflight supervision for nonbasic versions of sorties:

$$\sum_{j \in FL \cup IP} Y_{jpv} \geq \sum_{j \notin (FL \cup IP)} Y_{jpv} \quad \in SUP, v \neq 'B' \quad (2.28)$$

Definition of flight lead (FL):

FL = {NFL, XFL, XFMK, XFML, XFKL}

Inflight supervision for basic versions of sorties:

$$\sum_{j \in FL \cup IP} (Y_{jp,\, 'B'} + Y_{jp,\, 'IP'}) \geq \left(\sum_{j \notin (FL \cup IP)} Y_{jp,\, 'B'} - \sum_u RCIPSort_{pu} * Upgd_u \right) \quad \forall p \in SUP \tag{2.29}$$

Appendix C: F-15C Base Case RAND Meta-Model Spreadsheet

RAND Metamodel				
F-15C Base Case				
Input		Sorties		Sorties/Month
Inexperienced Wingmen	7	Inexperienced Wingmen	90.59925	12.94275
Experienced Wingmen	1	Experienced Wingmen	11.81205	11.81205
Flight leads and IPs	17	BMC	41.66256	10.41564
BMC pilots	4	MQT	10.83333	
ASD	1.2	Rear Cockpit	4.16667	
		Flight leads and IPs	211.4751	12.43971
		Monthly Sorties	400.1928	Sorties/pilot/mo
		Flying Hours Required	480.2314	13.79975326
		Yearly Sorties	4802.314	
		Yearly Flying Hours	5762.777	

Appendix D: F-15C Base Case RAP Spreadsheet

F-15C Base Case

Flying Hour Program Model

Notional F-XX

Squadrons	PMAI per Squadron	Assigned Unit PMAI	Adjusted Unit PMAI	Assigned Crew Ratio	Adjusted Crew Ratio	Wing Manning %	Assigned API-1 Pilots	Adjusted API-1 Pilots	% of Exp Pilots	% of InExp Pilots	# of Exp Pilots	# of InExp Pilots
1	18	18.0	18.0	1.25	1.28	100%	23.0	23.0	67%	33%	15.0	8.0

Atch CMR EXP in Unit	Atch CMR INEX in Unit	Atch BMC EXP in Unit	Atch BMC INEX in Unit	Atch API-8's in Unit
0	0	4	0	0

Legend
Do not change - calculations
Directed Requirements
Adjustable numbers

CMR EXP Sorties / Aircrew	CMR INEX Sorties / Aircrew	BMC EXP Sorties / Aircrew	BMC INEX Sorties / Aircrew	API-8 Sorties/ Aircrew	INST/AHC Sorties / Aircrew	Cost of Business (COB)	API-6/8 Percent	API-1 Percent	% COB
98	110	60	72	60	6	592	20.7%	79.3%	20.0%

Special Weapon Capabilities	CSAR Exp	CSAR Inexp		
	0	0	0	Crews
	6	8		Sorties/per/crew
	0	0	0	Total

UTE Data

Minimum UTE to meet RAP =	13.70	Sorties/Month/Aircraft
Standard home station UTE Rate =	16.44	Sorties/Month/Aircraft
UTE Rate to meet combined FHP =	16.44	Sorties/Month/Aircraft

HCM + SCM	API-1 HCM =	12.86
	API-1 SCM =	10.72
	API-6 SCM =	8.26
HCM + SCM Exp / InExp	Exp API-1 HCM	12.50
	Exp API-1 SCM	10.41
	InExp API-1 HCM	13.54
	InExp API-1 SCM	11.28

SORTIE REQUIREMENTS

1.) Sorties for API-1 Experienced Pilots =	1,470
2.) Sorties for API-1 Inexperienced Pilots =	880
3.) Sorties for API-6 SQ/CC & OPS =	196
4.) Sorties for CMR Staff Attached =	0
5.) Sorties for BMC Staff Attached =	240
6.) INST/AHC Sorties =	174
7.) Special Capabilities =	0
8.) COB Sorties =	592

HOME STATION SORTIES/HOURS

HS Sorties =	3,552
ASD =	1.20
HS Hours =	4,262

DOWN TIME ADJUSTMENT TO HS

HS ASD	HS UTE	PMAI	Months
1.20	13.4	0	0.00
		Sorties	Hours
		0	0

CONTINGENCY COMPUTATION

ASD	UTE	PMAI	Months
3.0	14.0	0	0.00
		Sorties	Hours
		0	0

Total Sorties	3,552
Total Hours	4,262

Appendix E: Equations for Sortie Optimization Linear Model for Base Case

Objective Function: Minimize $Z = X_1 + X_2 + X_3$ (E1)

Variables:

X_1 = Number of CMR experienced pilot sorties

X_2 = Number of CMR inexperienced pilot sorties

X_3 = Number of BMC Experienced pilot sorties

Y_1 = Number of API-1 Experienced pilot sorties per month

Y_2 = Number of API-1 Inexperienced pilot sorties per month

R_1 = Number of sorties for API-1 experienced pilots

R_2 = Number of sorties for API-1 inexperienced pilots

R_3 = Number of sorties for API-6 SQ/CC and DO

R_5 = Number of sorties for BMC staff attached pilots

R_6 = Number of instrument and AHC sorties

R_8 = Cost of Business sorties

Constraints:

$X_1 \geq 98$	Lower bounds for number of sorties	(E2)
$X_2 \geq 110$	Lower bounds for number of sorties	(E3)
$X_3 \geq 60$	Lower bounds for number of sorties	(E4)
$Y_1 \geq S_1 \in \{0, 11, 13\}$	Monthly sorties for API-1 Exp (problem specific)	(E5)
$Y_2 \geq S_2 \in \{0, 11, 13\}$	Monthly sorties for API-1 Inexp (problem specific)	(E6)
$0 \leq .89X_2 - X_1$	Keeps Exp API-1 sorties at 89% of Inexp API-1 sorties	(E7)
$0 \leq .54X_2 - X_3$	Keeps BMC sorties at 54% of Inexp API-1 sorties	(E8)
$-.5 = .0056R_1 + .0029R_8 - Y_1$	Maintains sortie ratios	(E9)

$-.5 = .0104R_2 + .0027R_8 - Y_2$	Maintains sortie ratios	(E10)
$0 = 15X_1 - R_1$	Calculation of API-1 experienced sorties	(E11)
$0 = 8X_2 - R_2$	Calculation of API-1 inexperienced sorties	(E12)
$-34.8 = .2R_1 + .2R_2 + .2R_3 + .2\,R_5 - R_8$	Calculation of COB sorties	(E13)
$0 = 4X_3 - R_5$	Calculation of BMC staff attached sorties	(E14)

Appendix F: Linear Model Validation for RAP Spreadsheet

Linear Model

TRUE		Name:	LP1	Solver:	Jensen LP/IP	Ph. 1 Iter.	9
FALSE	Change	Type:	LP1	Type:	Linear	Total Iter.	10
TRUE		Goal:	Min	Sens.:	No	Comp. Time	00:00
FALSE	Solve	Profit:	269.11	Side:	No	Status	Optimal
FALSE							
100	Change Relation						
100							
0							
60							

Variables	1	2	3	4	5	6	7	8	9	10
Name:	X1	X2	X3	Y1	Y2	R1	R2	R3	R5	R8
Values:	98	111.11	60	10.395	11.383	1470	888.89	196	240	593.78
Lower Bounds:	98	110	60	0	0	0	0	0	0	0
Upper Bounds:	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Linear Obj. Coef.:	1	1	1	0	0	0	0	0	0	0

Constraints

Num.	Name	Value	Rel.	RHS	Linear Constraint Coefficients									
1	CMR EXP	0.8889	>=	0	-1	0.89	0	0	0	0	0	0	0	0
2	BMC EXP	0	>=	0	0	0.54	-1	0	0	0	0	0	0	0
3	API-1E	-0.5	=	-0.5	0	0	0	-1	0	0.0056	0	0	0	0.0029
4	API-1I	-0.5	=	-0.5	0	0	0	0	-1	0	0.0104	0	0	0.0027
5	S API-1E	0	=	0	15	0	0	0	0	-1	0	0	0	0
6	S API-1I	0	=	0	0	8	0	0	0	0	-1	0	0	0
7	COB Sorties	-34.8	=	-34.8	0	0	0	0	0	0.2	0.2	0.2	0.2	-1
8	S API-6	0	=	0	2	0	0	0	0	0	0	-1	0	0
9	S BMC S	0	=	0	0	0	4	0	0	0	0	0	-1	0

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A COMPARISON STUDY OF F-15C FIGHTER SQUADRON READY AIRCREW PROGRAM FLYING HOUR SCHEDULING VS. THE RAND CORPORATION'S FLYING HOUR SCHEDULING LINEAR PROGRAM

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14. ABSTRACT

This research compares and contrasts the Flying Hour model created by the RAND corporation with the Ready Aircrew Program (RAP) model from Air Combat Command. The RAP model was designed to generate an annual flying hour program that specifies the minimum number of sorties required to stay tactically safe. The RAND model was designed to provide fighter pilots 13 sorties per month, a number determined from surveys of combat aviation leadership. The RAND model is built on the assumption that the fighter pilots would be immediately ready to deploy to a combat situation. In contrast, squadrons using the RAP model must take extra sorties and time to get fighter pilots ready for war. This research recommends an increase to AFI 1-2F-15V1 annual pilot requirements. This plus-up will increase average monthly sorties for combat mission ready API-1 pilots to the Air Force Safety Center recommended 11 flights per month at a flying hour cost of approximately $1.7 million per squadron.

15. SUBJECT TERMS

Ready Aircrew Program, RAP, RAND, flying hour program, fighter squadron flying scheduling

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