NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

OPTIMALLY SCHEDULING DISTRIBUTION OF THE MH-60S HELICOPTER AND PILOTS TO COMBAT SUPPORT (HC) SQUADRONS

by

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March 2002

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Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
29 Mar 2002	N/A	-

Title and Subtitle Optimally Scheduling Distribution of the MH-60S Helicopter and Pilots to Combat Support (HC) Squadrons	**Contract Number**
	Grant Number
	Program Element Number
Author(s) Culver, Cory	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Naval Postgradaute School Monterey, California	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es)	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes The original document contains color images.	
Abstract	
Subject Terms	
Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU
Number of Pages 89	

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REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** March 2002	**3. REPORT TYPE AND DATES COVERED** Master's Thesis	
4. TITLE AND SUBTITLE: Title (Mix case letters) Optimally Scheduling Distribution of the MH-60S Helicopter and Pilots To Combat Support (HC) Squadrons			**5. FUNDING NUMBERS**
6. AUTHOR(S) Culver, Cory L.			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) PMA 299, NAVAIR NAS Patuxent River, MD			**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited			**12b. DISTRIBUTION CODE**

13. ABSTRACT *(maximum 200 words)*

The U.S. Navy is replacing the H-46 helicopter with the new MH-60S helicopter. The Fleet Introduction Team has developed a spreadsheet-based schedule that distributes new aircraft and MH-60S trained pilots to the active duty Helicopter Combat Support squadrons. This thesis develops an optimal distribution schedule for helicopters and pilots using an integer programming model called OTHCAM (Optimal Transition, HC Allocation Model) that minimizes lost flying days. OTHCAM takes into account variable training durations, travel times and tour lengths, as well as manpower and aircraft constraints. The output is a distribution schedule for new MH-60S helicopters and Fleet Replacement Squadron graduates that minimizes lost flying days while meeting manpower and operational requirements. The schedule developed by OTHCAM reduces lost flying days by 26% compared to the Fleet Introduction Team's existing spreadsheet schedule.

14. SUBJECT TERMS Aviation, Helicopter, Schedule, Optimization, Modeling			**15. NUMBER OF PAGES** 89
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

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Optimally Scheduling Distribution of the MH-60S Helicopter and Pilots To Combat Support (HC) Squadrons

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MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
March 2002

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ABSTRACT

The U.S. Navy is replacing the H-46 helicopter with the new MH-60S helicopter. The Fleet Introduction Team has developed a spreadsheet-based schedule that distributes new aircraft and MH-60S trained pilots to the active duty Helicopter Combat Support squadrons. This thesis develops an optimal distribution schedule for helicopters and pilots using an integer programming model called OTHCAM (Optimal Transition, HC Allocation Model) that minimizes lost flying days. OTHCAM takes into account variable training durations, travel times and tour lengths, as well as manpower and aircraft constraints. The output is a distribution schedule for new MH-60S helicopters and Fleet Replacement Squadron graduates that minimizes lost flying days while meeting manpower and operational requirements. The schedule developed by OTHCAM reduces lost flying days by 26% compared to the Fleet Introduction Team's existing spreadsheet schedule.

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TABLE OF CONTENTS

LIST OF FIGURES

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LIST OF TABLES

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LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AIRPAC/ AIRLANT	Air Forces, Pacific/Atlantic
AOA	Analysis of Alternatives
C2F	Commander, Second Fleet
CNO	Chief of Naval Operations
CONUS	Continental United States
CY	Calendar Year
DT&OT	Development and Operational Testing
FIT	Fleet Introduction Team
FRS	Fleet Readiness Squadron
FY	Fiscal Year
GAMS	General Algebraic Modeling System
H-46	Helicopter, model 46
HAC	Helicopter Aircraft Commander
HC	Helicopter Combat Support Squadron
HMP	Helicopter Master Plan
IOC	Initial Operational Capability
LRIP	Limited Rate Initial Production
MH-60R	Multi-Purpose Helicopter, model 60, series R
MH-60S	Multi-Purpose Helicopter, model 60, series S
NAS	Naval Air Station
NAVAIR	Naval Air Systems Command
NS	Naval Station
OIC	Officer In Charge
OTHCAM	Optimal Transition, HC Allocation Model
PAA	Primary Aircraft Authorization
PMA	Program Management Analysis
PSQMD	Prospective Squadron Manning Document
VERTREP	Vertical Replenishment
VX	Experimental Aircraft Test/Evaluation Squadron

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ACKNOWLEDGEMENTS

I would like to thank PMA 299 and LCDR Rob Murphy for sponsoring this thesis. I also appreciate the patience and support of the Fleet Introduction Team and HC-3 in the collection of data to insure its completion.

I would like to express my deepest appreciation to Professors Kevin Wood and Gerald Brown for their profound assistance in the development of the mathematical model and eventual completion of this thesis.

I would also like to thank my wife, Kristen, for her patience in enduring the many late nights and weekends spent studying in order to reach this point.

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EXECUTIVE SUMMARY

The U.S. Navy is retiring the H-46 helicopter, which has been its primary vertical lift replenishment aircraft since 1964. The primary reasons for this retirement are increasing aircraft age, increasing maintenance costs and decreasing availability. The aircraft that is to replace the H-46 in the Helicopter Combat Support (HC) fleet is Sikorsky's MH-60S. Compared to the H-46, the MH-60S has greater payload, speed, flight duration and survivability. The MH-60S is expected to meet current HC mission requirements, as well as enable additional missions.

The Navy's Helicopter Master Plan (HMP) governs how the transition to the MH-60S will take place. The Fleet Introduction Team (FIT) was established at Naval Air Station (NAS) North Island, California, to implement the HMP. While the HMP introduced the modernization of the entire U.S. Navy helicopter fleet, it does not address the specific distribution schedule of MH-60S aircraft to fleet squadrons. The FIT has developed a spreadsheet-based distribution plan that introduces these aircraft into the fleet while continuing to meet current operational requirements. The FIT plan also distributes Fleet Replacement Squadron (FRS) graduates who have completed training in the MH-60S and are ready to join the active duty HC squadrons and fly the new aircraft. Each FRS graduate is one of three pilot types: Category I (Cat I) students are newly-winged aviators receiving initial flight training in fleet aircraft; Category II (Cat II) students are experienced H-46 pilots who are being retrained to fly the MH-60S; OIC students are senior Cat II pilots who will take on department head duties in their assigned active duty HC squadron.

While the FIT spreadsheet plan distributes aircraft and pilots to the active duty HC squadrons, it is not optimal with regards to minimizing lost flying days. A lost helicopter flying day, or "fly day", is defined in this thesis as a day spent by an MH-60S aircraft waiting in its assigned squadron for an MH-60S trained crew to arrive from the FRS. Similarly, a lost pilot fly day is defined as one FRS graduate waiting in an assigned squadron for an MH-60S helicopter.

The purpose of this thesis is to develop an optimal distribution of aircraft and pilots to the HC squadrons that minimizes lost helicopter and pilot fly days through FY 2005. By that time, the active duty HC community will have received the minimum number of aircraft required to conduct the HC mission for the fleet.

There are many factors that determine the timing of when aircraft and pilots arrive at their fleet squadrons. There is an established production schedule for the MH-60S at the Sikorsky plant in Stratford, CT. An FRS class schedule has also been developed that forecasts class start dates and the number of each type of pilot that will make up each class. An FRS class can consist of any mixture of the three pilot types. The FRS curriculum length varies for each type of student, so individual FRS students in each class may complete their training at different times. FRS graduates are promptly sent to their assigned HC squadron for duty after graduation. The time a graduate spends traveling from the FRS in San Diego, California, to the assigned HC squadron depends upon the geographic location of that squadron. Similarly, travel time for a MH-60S helicopter will vary based upon which squadron it is distributed to.

There are a number of constraints on any distribution schedule. Each active duty HC squadron is allocated a total number of aircraft and has personnel limits for pilot types set forth by Prospective Squadron Manning Documents (PSQMDs). HC squadrons deploy in small groups known as detachments which generally consist of two helicopters, one OIC, two Cat II pilots and three Cat I pilots. A MH-60S aircraft distributed to a squadron is defined as flyable only if half of the personnel of a standard HC detachment is currently in the same squadron. In other words, there must be 0.5 of an OIC, one Cat II, and 1.5 of a Cat I available for each flyable helicopter. Similarly, MH-60S pilots are only considered flyable if they are part of a half-detachment and an aircraft is available.

An integer programming model called OTHCAM (Optimal Transition, HC Allocation Model) is developed in this thesis to optimally schedule the distribution of pilots and helicopters to the squadrons. A combined objective function is used consisting of lost helicopter fly days due to the lack of MH-60S trained crews and lost pilot fly days due to a shortage of helicopters in the squadron. OTHCAM finds an optimal integer distribution schedule that accumulates 26% fewer total lost fly days than the current FIT spreadsheet plan over the planning horizon available for the given data.

It is difficult to compare the results proposed by OTHCAM and the FIT spreadsheet plan for several reasons. First and most importantly, the FIT plan distributes helicopters and pilots in blocks in order to support operational considerations without regard to lost fly days, whereas OTHCAM distributes these assets to minimize lost fly days. Secondly, the FIT plan distributes MH-60S aircraft to many types of squadrons, while OTHCAM is only concerned with the four active duty HC squadrons. This makes the FIT planning horizon much longer than OTHCAM's. Third, OTHCAM allocates helicopters to the fleet squadrons each month in which at least one is produced. The FIT plan does not always allocate a helicopter during the month it is produced; rather, the plan may allow the helicopter to sit idle for distribution later. To allow the OTHCAM and FIT solutions to be compared, the FIT distribution of helicopters has been amended slightly to match Sikorsky's production schedule. Finally, the FIT plan does not conform to the PSQMDs, which are created by each fleet squadron to determine the number of personnel required for mission completion, and which establish the manning constraints used by OTHCAM.

Although not considered essential by the sponsor of this thesis, additional constraints required by the FIT concerning the distribution of MH-60S helicopters prior to July 2004 have been included in one version of OTHCAM to convince the FIT of the model's viability and to help validate the FIT plan. This adaptation of OTHCAM yields a result that allows 22% fewer lost fly days than the FIT plan. The FIT has since updated its spreadsheet plan.

The accumulation of lost fly days is wasteful in terms of training opportunities and manpower costs. OTHCAM is an effective model for determining the efficient allocation of MH-60S helicopters and FRS graduates to the active duty HC squadrons and should be considered as an optimal alternative to the FIT spreadsheet plan, or at least as a source of insightful advice on how to improve the current FIT plan.

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I. INTRODUCTION

This study develops an optimal distribution schedule of MH-60S helicopters and Fleet Replacement Squadron (FRS) graduates to the active duty Helicopter Combat Support (HC) squadrons that minimizes wasted helicopter and pilot flying days. A lost helicopter flying day, or “fly day”, is defined in this thesis as a day spent by an MH-60S aircraft waiting in its assigned squadron for an MH-60S trained crew to arrive from the FRS. Similarly, a lost pilot fly day is defined as one FRS graduate waiting in his or her assigned squadron for an MH-60S helicopter. Lost fly days are wasteful in terms of training opportunities and manpower costs.

A. BACKGROUND

While the Navy began experimenting with the transfer of cargo from ship-to-ship using helicopters as early as 1958, the introduction of Boeing’s H-46 into the fleet in 1964 was the significant factor that established Vertical Replenishment (VERTREP) as the standard for supplying ships at sea. In 1965 the HC, or “Helicopter Combat Support” community was officially designated and began to use the unique capabilities of the H-46 to provide improved logistic services to the fleet (C2F 1999). The H-46 (Figure 1) is a twin rotor, dual-engine, multi-purpose aircraft.

Figure 1. Boeing’s H-46 Helicopter.
The “work horse of the fleet” is used by the U.S. Navy, the Marine Corps and various countries including Canada, Sweden, Japan, and Saudi Arabia.

The primary missions of the HC helicopter include day or night VERTREP, airborne personnel transfer, day or night amphibious search and rescue, and airbase replenishment operations. Secondary missions include over-water special warfare support; recovery of torpedoes, drones, unmanned aerial and undersea vehicles; noncombatant evacuation operations; aeromedical evacuations; humanitarian assistance and disaster relief; station search and rescue, range support and executive transport.

In the early 1990s, the Navy operated eight different types of helicopters, including the H-46. Studies initiated by the Navy's rotary wing community and the Naval Air Systems Command (NAVAIR) led to the development of the Navy's Helicopter Master Plan (HMP); see Figure 2. The Helicopter Master Plan is the roadmap developed to reduce helicopter types and to realize cost savings by using only two models of a single airframe in the fleet, the MH-60R and MH-60S (NAVAIR 2001a). Jasperson (1999) and Lopez (2000) discuss the HMP in some detail, and those two Master's theses provide part of the framework for the current thesis.

The reduction to two models of the same type helicopter, with maximum commonality of components, will yield significant savings to the Navy in both acquisition costs, and operations and support costs. In fact, recent estimates predict an overall savings of over $20 billion in airframe life-cycle costs alone. These estimates do not count synergistic benefits created by reducing from eight down to two different helicopter models (C2F 1999). Such benefits include reduced inventories of parts and support equipment resulting from increased commonality of parts and procedures. It is possible that those yet to be quantified costs will eclipse the $20 billion in up front savings.

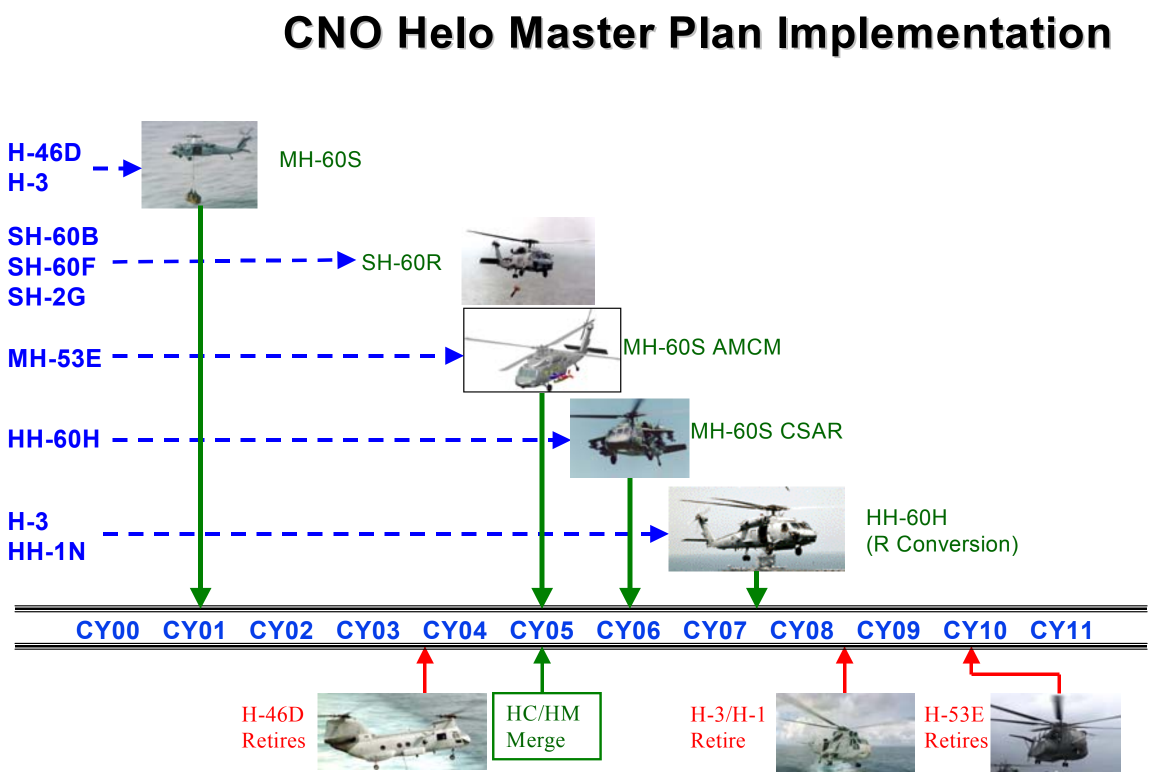

Figure 2. Helicopter Master Plan to Reduce Fleet to Two Models of the MH-60
Until CY 2000, the Navy used the eight different helicopter types listed on the left (C2F 1999). Two versions of the basic MH-60 airframe, the MH-60R and the MH-60S, will carry out the missions previously performed by the eight older types. Modifications to the two models of the MH-60 will allow one base helicopter to complete multiple missions such as airborne mine countermeasures and combat search and rescue. The dashed lines indicate how helicopter missions will be reassigned to the two MH-60 models. The calendar years listed on the bottom show the anticipated transition schedule.

The HC community requires ninety-two airframes to sustain battle group combat support requirements. The principal shortcoming of the H-46D HC Helicopter is an inventory shortfall of 21 airframes in fiscal year (FY) 2001 (up from a projected number of 19 in calendar year (CY) 1998). Contributing to this inventory shortfall is the age of the H-46D, whose service life began in the mid 1960s and whose original service life of 10,000 flight hours has already been exceeded by 57 of the current 71 airframes. Currently, the Maintenance Man Hour per Organizational Flight Hour rate for the H-46D is 30 hours/hour, which represents an 11% growth in two years. By comparison, the rate for the HH-60H (a current Navy H-60 variant) is 18.5. The H-46D also requires a non-destructive inspection of its rotor head every 10 flight hours. No other naval helicopter has such a requirement (NAVAIR 2001a).

The Analysis of Alternatives (AOA) for the HC Helicopter program was approved by the Chief of Naval Operations Resources, Requirements and Assessments office on 10 May 1996. The AOA supports the procurement of Sikorsky's MH-60S as the most cost-effective approach to meeting HC mission requirements (Figure 3).

Figure 3. Sikorsky's MH-60S Helicopter.
The "Sierra" model of the H-60 is derived from the Army's UH-60 Blackhawk airframe and has been modified to operate from ships at sea. Compared to the H-46, the MH-60S has greater payload, speed, flight duration and survivability (NAVAIR 2001a).

The MH-60S is a modified in-production helicopter, which provides maximum commonality with the US Navy H-60 and US Army UH-60L currently in service and is fully supported by the Department of Defense logistics system (NAVAIR 2001a). The MH-60S will not only perform the current missions of the H-46, but also anti-surface warfare and organic airborne mine countermeasures missions.

B. PROBLEM DESCRIPTION

The Helicopter Master Plan has many strengths, but it is solely an acquisition strategy. It does not address employment or force structure. The balanced integration of each of these aspects will yield a rotary-wing force optimized for the tactical and operational environment of the future. A plan must be developed that enables a smooth and rapid introduction of these aircraft into the fleet while continuing to meet current operational requirements (C2F 1999). The H-60 Romeo and Sierra (R/S) Fleet Introduction Team (FIT) has been established at Naval Air Station (NAS) North Island to develop and assist in administering this plan. The joint Air Forces, Pacific/Atlantic (AIRPAC/AIRLANT) instruction establishing the FIT defines it as the single point of contact for all fleet input and guidance to program offices that will manage all fleet introduction issues pertaining to the MH-60R/S. Furthermore, the instruction charges the FIT to ultimately lead the transformation of the Navy helicopter community as outlined in the Helicopter Master Plan (FIT 1997).

The first H-60S was delivered to the Navy in April of 2000, with the intention of populating the entire active duty HC fleet by FY 2009. The replacement timeline is complicated by the fixed retirement date of all H-46 aircraft at the end of June 2004 (NAVAIR 2001b). Table 1 shows a portion of the airframe delivery schedule beginning with aircraft bureau number 165742.

Fiscal Year of Production		**Fiscal Year 2000**												**Fiscal Year 2001**											
Month of Production		**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**
Number of Aircraft Produced								**1**	**2**	**1**	**1**		**1**			**4**			**1**	**1**	**1**	**2**	**1**	**2**	**2**
Squadrons Aircraft are Distributed To	**Total Aircraft Allocated to Squadron**																								
Rotary Wing	**3**							**1**	**2**																
VX-1	**3**										**1**		**1**						**1**						
HC-3	**10**									**1**						**4**				**1**	**1**	**2**	**1**		
HC-5	**4**																							**2**	**2**

Table 1. Limited Rate Initial Production (LRIP) Delivery Schedule.
The numbers in the "Number of Aircraft Produced" row show the number of MH-60S airframes Sikorsky will turn over to the Navy in the months listed in the "Month of Production" columns. The number of airframes allocated to the commands listed in the "Distributed" rows are shown by the applicable numbered blocks. For example, Rotary Wing receives the first MH-60S airframe in April of FY 2000.

Prior to entering full production, Sikorsky delivered aircraft to the Navy according to a Limited Rate Initial Production (LRIP) schedule. This continuous, low-rate production provides the Navy with the aircraft used for development and operational testing (DT&OT), as well as the initial fleet aircraft, without incurring the high cost of starting up and shutting down the Sikorsky production line: it would be much more expensive if Sikorsky only built the required DT&OT airframes, shut down its production line, and then started up full-rate production when the DT&OT phase was complete. Instead, additional aircraft are produced during the DT&OT phase, with the intention of completing any modifications identified during DT&OT at a later date.

As Table 1 shows, the first LRIP airframes have been used for DT&OT by the Naval Rotary Wing Aircraft Test Squadron and VX-1 at NAS Patuxent River, MD. Ten airframes are designated for HC-3 at NAS North Island, which is the HC single-site Fleet Replacement Squadron (FRS). The FRS trains newly designated pilots, arriving from initial flight training at NAS Whiting Field, to conduct HC missions using fleet aircraft. The FRS also retrains experienced fleet pilots who have recently held non-flying Navy billets or are transitioning from the H-46 to the MH-60S. The four airframes produced in August and September of fiscal year 2001 are reserved for HC-5 based at Anderson AFB in Guam to establish fleet Initial Operational Capability (IOC). IOC will be achieved when the first MH-60S helicopter detachment is deployed with personnel having completed required maintenance and operational training. IOC is to occur no later than the end of FY 2002 (NAVAIR 2001a). The delivery schedule for the remaining MH-60S airframes to the HC community is currently in question.

C. THESIS PURPOSE AND PROBLEM FRAMEWORK

The purpose of this thesis is to develop an optimal delivery schedule of MH-60S airframes and FRS graduates for the active duty HC community through FY 2005. By that time, the active duty HC community will have reached its Primary Aircraft Authorization (PAA), which defines the minimum number of aircraft required to conduct the HC mission for the fleet. An optimal schedule will minimize the number of potential fly days lost because of helicopters waiting at fleet squadrons for trained MH-60S pilots to arrive and, similarly, retrained pilots waiting for helicopters. PMA 299, the Navy's Multi-Mission Helicopter Program Manager at NAS Patuxent River, is responsible for determining the distribution of MH-60S airframes from Sikorsky to the fleet. The FIT currently has a feasible airframe distribution plan based on contractual and projected production schedules from Sikorsky (Appendix A). PMA 299 is interested in a distribution schedule that minimizes gaps between arrival of MH-60S airframes and sufficient crews trained to fly them at HC-5 at Anderson AFB, HC-6 and HC-8 at Naval Station (NS) Norfolk, and HC-11 at NAS North Island. That is, PMA 299 wants to minimize lost fly days.

There are many factors that determine the timing of when airframes and pilots arrive at their fleet squadrons. As seen in Table 1 and Appendix A, there is an established production schedule for the Sikorsky plant at Stratford, CT. Airframes are normally turned over to the Navy during the last week of a production month; therefore the final day of each month is used as the estimated date of transition (Sikorsky 2001). The actual delivery of the airframe from Stratford to the squadron's location is either by cross-country flight, or in the case of HC-5, by a combination of cross-country flight to the west coast and shipment via container ship to Guam. The number of days to complete this delivery is obviously dependent on distance traveled (Table 2).

Two factors affect the arrival of MH-60S trained pilots at their fleet squadrons after training at HC-3. Similar to airframe delivery, the number of days in transit from NAS North Island to assigned fleet squadron will vary depending on the geographic location of that pilot's fleet squadron (Table 2).

	Days in Transit (days)				
Source/Destination	**HC-3**	**HC-5**	**HC-6**	**HC-8**	**HC-11**
Sikorsky (aircraft)	8	38	1	1	8
HC-3 (pilots)	n/a	17	7	7	1

Table 2. Transit Days for Airframes and Pilots to HC Squadrons.
Each helicopter begins its travel from the Sikorsky plant in Stratford, CT. Likewise, each pilot initiates travel from the FRS at HC-3 at NAS North Island, CA.

Additionally, pilot availability depends upon completion of the FRS syllabus. Training cycles at HC-3 vary depending upon the category of student pilot. A Category I student is a newly-designated aviator from flight school. Because Category I pilots lack fleet aircraft experience, the "Cat I" syllabus is longer than the Category II syllabus, which is for fleet H-46 pilots being retrained to fly the MH-60S. The "Cat II" syllabus is identical for pilots called "OICs" who will assume department head positions in their assigned fleet squadron. The FIT has projected FRS class start dates through the end of FY 2005 (Appendix B). These FRS classes do not include the initial cadre of MH-60S pilots that will complete the IOC at HC-5. FRS classes, comprising various combinations of Cat I, Cat II and OIC students, will begin training together but will end their FRS training at different times based upon cycle length and other factors including weather delays and additional schools that may be required but are not part of the FRS syllabus. Estimates of actual student pilot training time spent at NAS North Island before transitioning to the fleet squadrons are made using the proposed MH-60S syllabi adjusted by historical student completion data from HC-3 (HC-3a 2001); see Table 3.

Category of Student Pilot	Total Training Time (days)
Category I	157
Category II	142
OIC	142

Table 3. Time to Complete the FRS for the Three Pilot Categories.
Total training time is calculated using the proposed MH-60S syllabi created by HC-3 plus two weeks to account for training delays caused by inclement weather, possibly required schools that are not part of the FRS syllabus, and post-graduation leave (HC-3b 2001)

There are a number of constraints on any distribution schedule. Each squadron has a specific number of airframes that it will ultimately be allocated, regardless of the distribution schedule (Table 4).

Squadron	Number of Allocated Aircraft
HC-5	14
HC-6	16
HC-8	16
HC-11	23

Table 4. Number of MH-60S Airframes Allocated to Each Squadron.
HC-11 receives the most aircraft since it is the only HC squadron to directly support ships based on the west coast of the United States. HC-6 and HC-8 are collocated at NS Norfolk and can share fleet support responsibilities.

Similarly, each squadron has projected upper and lower bounds on the number of each type of pilot that it should have over the planning horizon, which ends when all HC squadrons have received their allocation of MH-60S airframes and transition is complete (Table 5). Personnel levels are prescribed by each squadron's Prospective Squadron Manning Document (PSQMD). HC squadrons send personnel to sea in detachments that provide helicopter support to the ship to which they are assigned. The PSQMD estimates the number of each type of pilot that a squadron requires in order to man its detachments.

Each squadron is unique in the number of detachments it is expected to have. According to the PSQMDs, detachments typically consist of one OIC, two other aircraft commanders (Cat IIs) and five Cat Is (NAVAIR 1998). In practice, a standard HC detachment only has three Cat Is, or 60% of the PSQMD specification. The two Norfolk-based squadrons, HC-6 and HC-8, each have two smaller detachments consisting of one OIC, one Cat II, and two Cat Is. HC-5 in Guam, the only forward-deployed HC squadron, has the unique requirement of having to maintain one "homeguard" detachment that consists of two OICs, thirteen Cat IIs and twenty-five Cat Is (NAVAIR 1998). The number of pilots required to man a squadron's detachments represents the lower bound on the number of pilots each squadron should have at the end of the planning horizon. However, squadron spaces can only support so many personnel; therefore the upper bound on the number of pilots of each type can be assigned to each squadron will be some percentage above the number called for by the PSQMD (see Table 5).

Category of Pilot	**Maximum Allowed in Each Time Period**	**Minimum Required at End of Planning Horizon**
Category I	70% of PSQMD	60% of PSQMD
Category II	150% of PSQMD	100% of PSQMD
OIC	125% of PSQMD	100% of PSQMD

Table 5. Upper and Lower Bounds on Pilot Types for HC Squadrons.
The number of Cat I graduates available from the FRS do not meet PSQMD requirements. Furthermore, the actual number of Cat Is per typical detachment is less than the PSQMD requirement. A significantly greater number of Cat II pilots are allowed in each squadron compared to the PSQMD requirement due to the mass retraining of H-46 fleet pilots.

When a trained MH-60S pilot arrives at a fleet squadron, the H-46 pilot he replaces immediately departs for retraining at the FRS. Tour length for a pilot upon arrival at the fleet squadron varies according to the type of training received at the FRS and the squadron assigned (FIT 2001a); see Table 6.

	Length of Tour (months)		
Squadron	**Cat I**	**Cat II**	**OIC**
HC-5	36	24	24
HC-6	42	24	24
HC-8	42	24	24
HC-11	42	24	24

Table 6. Tour Lengths at Fleet HC Squadrons for the Three Pilot Categories.
The tour for a Cat I pilot is longer than for a Cat II or OIC pilot to give the Cat I pilot time to gain fleet experience and become an aircraft commander (HAC). Cat I pilots at HC-5 have a shorter tour than their counterparts based in the continental U.S. (CONUS) because of the high operational tempo and quality-of-life hardships unique to being stationed overseas.

Each squadron must have a certain number of each type of pilot at any given time to maintain combat effectiveness. Therefore, as pilots of a certain type leave a fleet squadron at the end of their tour, sufficient pilots of the same type must be scheduled to arrive at that squadron as replacements. After gaining enough fleet experience during a tour, a Category I pilot becomes a helicopter aircraft commander (HAC). This "promotion" generally occurs before two years at the CONUS-based squadrons and eighteen months at HC-5 (HC-3 2001b). Being named a HAC makes the experienced Cat I pilot essentially the same as a Cat II pilot. Therefore, each squadron will "lose" a Cat I pilot and "gain" a Cat II pilot after the Cat I pilot becomes a HAC.

Finally, a certain number of each type of pilot must be assigned to a squadron for a helicopter to be defined as "flyable." HC squadrons send personnel to sea in detachments, typically consisting of one OIC, two Cat IIs and three Cat Is, that operate two helicopters. Therefore, each flyable helicopter in a squadron requires one half of a standard HC detachment of pilots.

The next chapter of this thesis introduces an integer programming model that uses these data and constraints to schedule the distribution of helicopters and pilots to the active HC squadrons. By optimizing the distribution schedule, inventories of helicopters and pilots are created that minimize lost fly days.

II. FORMULATION

An integer programming model called OTHCAM (Optimal Transition, HC Allocation Model) is developed here to optimally schedule distribution of pilots and helicopters to each squadron. A composite objective function is used, combining lost helicopter fly days due to the lack of MH-60S trained crews and lost pilot fly days due to a shortage of helicopters in the squadron. Pilots are defined as category I, II, or OIC. OTHCAM produces a schedule that distributes FRS graduates to squadrons by FRS class and helicopters by month and year of production.

A. DEFINITION OF TERMS

The following terms are used to explain OTHCAM's mathematical formulation. They are re-defined here to eliminate ambiguity and to provide easy reference.

FRS – Fleet Replacement Squadron. Located at NAS North Island, San Diego, CA, the FRS trains aviators to fly a specific fleet aircraft. The HC FRS, HC 3, has trained aviators to fly the H-46, and will now train them on the MH-60S.

student – FRS students are either newly-winged aviators that have just finished initial flight training (Cat I) or fleet pilots trained to fly the H-46 and requiring retraining in the MH-60S (Cat II). A subset of Cat II pilots, Officers-in-Charge (OIC), are earmarked for department head positions in the fleet squadron they are assigned to.

syllabus – FRS students must complete a training cycle at HC 3 before being assigned to a fleet squadron. This training consists of ground school as well as flight events to familiarize the student with the FRS aircraft. The length of training is dependent on the type of student. The Cat I syllabus is longer than the Cat II and OIC syllabi because Cat I pilots have less fleet aircraft experience.

time period – The planning horizon is divided into equal time periods which can be set to any number of days. Pilots and helicopters move through the model from time period to time period. This allows for slack in FRS completion, travel times and tour lengths.

class – Students are organized into classes to complete their training. A new class is started about every two weeks and continues until the syllabus for each type of student is completed. Classes can consist of Cat I, Cat II and OIC students.

squadron – A squadron is defined in this thesis as a fleet command that has flown the H-46 and is transitioning to the MH-60S. Each pilot trained at the FRS is then assigned to a fleet squadron.

helicopter – The aircraft here is the Sikorsky MH-60S.

sequence day – One day in a series of days covering the entire planning horizon; this horizon is chosen to begin on 1 October 2001 because that month is when the first unclaimed MH-60S airframe will be turned over to the Navy.

tour – Each pilot assigned to a fleet squadron will remain there for a specified length of time dependent upon which category of student the pilot was at the FRS as well as which fleet squadron the pilot is assigned to.

flyable – A helicopter is flyable if there is half of a standard HC detachment in the same squadron per helicopter. A standard HC detachment consists of 1 OIC, 2 Cat II pilots, and 3 Cat I pilots. Therefore, a half of a detachment is made up of 0.5 of an OIC, one Cat II and 1.5 of a Cat I.

B. FORMULATION

The formulation of OTHCAM as an integer program is:

1. Indices

c category of student pilots (c1, c2, oic)

$\tilde{c}$ category of student pilot when he enters his assigned squadron

$\hat{c}$ category of student pilot when he completes his squadron tour

k FRS class listed by year and month (0203, 0204,…,0523)

s squadron (HC5, HC6, HC8, HC11)

h year and month of helicopter production (0110, 0111,…,0508)

t, t' time period (1, 2,…,T)

2. Data

$studs_{c,k}$ students of category c beginning FRS class k (persons)

$pday_k$ sequence day for start of FRS class k

syl_c length of FRS syllabus for category c (days)

$ptrvl_s$ days for FRS graduate to travel to fleet squadron (days)

$daysppd$ length of time period in days

α weight in the composite objective function, ranging from 0 which emphasizes lost helicopter fly days, to 1 which emphasizes lost pilot fly days

$psply_{c,t}$ supply of FRS graduates to fleet squadrons (persons)

$pmax_{c,s}$ maximum number of category c pilots allowed in squadron s (persons)

$pminend_{c,s}$ minimum number of category c pilots needed in squadron s at the end of the planning horizon (persons)

$detpersons_c$ number of pilots of each category required to define an HC detachment (persons)

$dethelos$ number of helicopters assigned to a typical HC detachment (helos)

$tour_{\tilde{c},\hat{c},s}$ days in squadron s tour, arriving in role $\tilde{c}$, leaving in role $\hat{c}$ (days)

$hday_h$ sequence day of helicopter production

$helos_h$ helicopters produced per production period h (helos)

$hsply_t$ new supply of helicopters shipped from Sikorsky during period t (helos)

$htrvl_s$ days for helicopter to travel from factory to fleet squadron (days)

$hmax_s$ number of helicopters in squadron s at the end of the planning horizon (helos)

The following derived data provide a means to express travel time for helicopters and pilots as well as tour lengths for pilots in time periods rather than days.

$helopds_s$ $\equiv \lfloor htrvl_s / daysppd + .5 \rfloor + 1$ (periods)

$pcspds_s$ $\equiv \lfloor ptrvl_s / daysppd + .5 \rfloor + 1$ (periods)

$tourpds_{\tilde{c},\hat{c},s}$ $\equiv \left\lfloor (\sum_{c=\tilde{c}}^{\hat{c}} tour_{\tilde{c},c,s}) / daysppd + .5 \right\rfloor + pcspds_s$ (periods)

3. Variables

$P_{c,s,t}$ pilots of category c assigned to squadron s available during time period t (persons)

$H_{s,t}$ new helicopters to leave for squadron s during period (helos)

$IP_{c,s,t}$ inventory of pilots of category c in squadron s in period t (persons)

$IPF_{c,s,t}$ inventory of type c pilots at squadron s in period t who can fly because sufficient helicopters are available (persons)

$IHF_{s,t}$ inventory of helicopters at squadron s in period t that can fly because sufficient pilots of the correct type are available (helos)

4. Objective Function

$$losthelodays = daysppd \times \sum_{s,t} \left(\sum_{t' \le t} H_{s,t'-helopds_s} - IHF_{s,t} \right)$$ total cost of helicopter use

$$lostpilotdays = daysppd \times \sum_{c,s,t} (IP_{c,s,t} - IPF_{c,s,t})$$ total cost of pilot use

$$\alpha \times losthelodays + (1.0 - \alpha) \times lostpilotdays$$ composite objective function

5. Constraints

1. Helicopters that become available during period *t* must be allocated among and start trips to squadrons during that period.

$$\sum_{s} H_{s,t} = hsply_t \qquad \forall t$$

2. All new helicopters having arrived at squadrons constitute the existing fleet.

$$IHF_{s,t} \le \sum_{t' \le t} H_{s,t'-helopds_s} \qquad \forall s,t$$

3. Helicopter strength of each squadron *s* at the end of the planning horizon must meet requirements.

$$\sum_{t} H_{s,t-helopds_s} = hmax_s \qquad \forall s$$

4. Each flying helicopter can support at most 8 flying pilots.

$$8 \times IHF_{s,t} \geq \sum_{c} IPF_{c,s,t} \qquad \forall s,t$$

5. All pilots of category *c* who finish training in period *t* must commence travel to some squadron *s*.

$$\sum_{s} P_{c,s,t} = psply_{c,t} \qquad \forall c,t$$

6. The total inventory of pilots consists of all new pilots having arrived, plus transitions from category I to category II, less all those having completed their tours, is the total inventory of pilots.

$$\sum_{t' \leq t} (P_{c,s,t'-pcspds_s} + I(c) \times (P_{'c1',s,t'-tourpds_{'c1','c1',s}} - P_{'c1',s,t'-tourpds_{'c1','c2',s}}) - P_{c,s,t'-tourpds_{c,c,s}}) = IP_{c,s,t}$$

$$I(c) = 1 \text{ if } c = 'c2', 0 \text{ otherwise} \qquad \forall c,s,t$$

7. The number of flying pilots cannot exceed the number of pilots in the squadron.

$$IPF_{c,s,t} \leq IP_{c,s,t} \qquad \forall c,s,t$$

8. There must be sufficient personnel if a helicopter is to be classified as "flyable."

$$IHF_{s,t} \leq (dethelos / detpersons_c) \times IP_{c,s,t} \qquad \forall c,s,t$$

9. All variables are non-negative and integer, the inventory of each pilot type has an upper bound in each time period and lower and upper bounds at the end of the planning horizon.

$P_{c,s,t} \geq 0$ and integer	$\forall c,s,t$
$H_{s,t} \geq 0$ and integer	$\forall s,t$
$IPF_{c,s,t} \geq 0$ and integer	$\forall c,s,t$
$IHF_{s,t} \geq 0$ and integer	$\forall s,t$
$0 \leq IP_{c,s,t} \leq pmax_{c,s}$ and integer	$\forall c,s,t$
$pminend_{c,s} \leq IP_{c,s,t}$ and integer	$\forall c,s$
	$t = T$

5. Notes

In the implementation of OTHCAM, the only variables that are specifically designated as integer variables are $P_{c,s,t}$ and $H_{s,t}$. The remaining inventory variables are continuous, but usually take on integer values. With no ambiguity, we have found it convenient and expeditious to relax the integer requirement of the inventory variables. Significant computation time is saved by only requiring two of the five sets of variables to be integer.

Constraints 2 and 6, are formulated in "cumulant" form rather than as standard inventory balance equations (Brown, Dell, Wood 1997). The total number of helicopters that arrive at a squadron up to time *t* constitutes the current inventory of helicopters in that squadron because helicopters never leave a squadron once assigned. Computation time is saved by defining helicopter inventory in this manner rather than using explicit inventory variables. Conversely, pilots may arrive at or leave a particular squadron during a given time period. However, this adjustment is made to the cumulative total of pilot arrivals and departures from all previous time periods to define the current pilot inventory.

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III. DATA COLLECTION

This chapter describes where and how OTHCAM's data was obtained and/or derived.

A. DATA SOURCES

Data for OTHCAM has been collected from many sources including the H-60R/S FIT, NAS North Island CA (FIT 2001a); the Multi-Mission Helicopter Program Office (PMA 299), NAS Patuxent River MD (NAVAIR 2001a); HC-3, NAS North Island CA (HC-3 2001a); NAVAIR Team AIR 3.4.1, NAS Patuxent River MD (NAVAIR 1998); the Second Fleet Commander's Helicopter Reorganization Study (C2F 1999); and Dave Haines, Sikorsky's MH-60S Program Manager (Sikorsky 2001). Most of the data has been collected during internships by the author at the commands listed.

B. DESCRIPTIONS OF DATA

$studs_{c,k}$: The FRS class schedule from 1 November 2001 until 21 November 2005 is obtained from the FIT (FIT 2001a). The FIT uses the same class schedule to determine their planned allocation of MH-60S airframes to the fleet.

$pday_k$: The FRS class start dates are known from the class schedule described above. A sequential timeline has been created with 1 October 2001 assigned as day one. This timeline extends for the duration of the planning horizon and provides a means to map significant dates (distinct points in time) to a time interval.

syl_c: The MH-60S FRS syllabi lengths for Cat I, Cat II and OIC students have been approximated by HC-3 based on the syllabi used by other FRS squadrons that currently fly the H-60 (HC-3 2001a). Total training time is calculated using the proposed MH-60S syllabi created by HC-3 plus two weeks to account for training delays because of weather, schools that may be required but are not part of the FRS syllabus, and post graduation leave (HC-3b 2001). This estimate comes from the student training officer at HC-3.

$ptrvl_s$, $htrvl_s$: The number of days for pilots and helicopters to travel from the FRS and the Sikorsky plant in Stratford to squadron *s*, respectively, is based on an estimate from PMA 299 (NAVAIR 2001c). It is assumed that pilots will not take significant leave after completing the FRS except for pilots assigned to HC-5 in Guam. HC-5 pilots are given an additional two weeks of travel time to account for the extended leave historically taken by HC pilots given orders overseas. Travel time for helicopters from the Sikorsky plant to their assigned squadron is determined by the flight time historically needed to fly the new helicopters to their destinations. Travel time for a helicopter to HC-5 includes seven days of flight time from Stratford to the west coast followed by thirty days to be transported by ship to Guam.

$daysppd$: The planning horizon is divided into time periods that are currently set at ten days. This allows for slack of a third of a month in FRS completion, travel times and tour lengths.

α: Each component of the composite objective function comprises a variable fraction of the total based upon the priority given to lost helicopter fly days versus lost pilot fly days. As α increases from 0 to 1, more emphasis is placed on lost helicopter fly days and less emphasis on lost pilot fly days. This gives the decision maker flexibility to weigh the importance of one aspect of the composite objective function more than the other, as desired.

$psply_{c,t}$: The variability of FRS syllabi lengths means that members of an FRS class will not all complete their training at the same time. As soon as a student in some category completes the FRS, the student is given orders and proceeds to the assigned fleet squadron.

$pmax_{c,s}$: The maximum number of each type of pilot in a squadron is based on an estimated percentage of the requirements set forth by each squadron's unique PSQMD. This estimate is determined by the maximum number of each type of pilot that is in the active HC squadrons during any time period. For example, if the number of Cat IIs in the HC squadrons in a certain time period is 150% of the total number specified in the PSQMDs, and there are more Cat IIs in the HC squadrons during that time period than any other in the planning horizon, then the maximum number of Cat IIs allowed in each squadron is 150% of what the squadron's individual PSQMD calls for.

$pminend_{c,s}$: The minimum number of each type of pilot in a squadron at the end of the planning horizon is also based upon the PSQMD. The number of OIC and Cat II pilots must be at least equal to those called for by the PSQMD. The number of Cat I pilots is allowed to be only 60% of the PSQMD requirement. In practice, a standard HC detachment only has three Cat Is, or 60% of the PSQMD specification (NAVAIR 1998).

$detpersons_c$, $dethelos$: The manning structure and number of helicopters assigned to a typical HC detachment is obtained from the HC-3 Student Training Officer (HC-3b 2001).

$tour_{\tilde{c},\hat{c},s}$: The basic length of a squadron tour for the different types of pilot is from the spreadsheet the FIT uses to determine their allocation of FRS graduates (FIT 2001a). The tour length for Cat I pilots is shortened to account for their "promotion" to Cat II status after becoming aircraft commanders. This tour length is based on a conservative estimate by the HC-3 Student Training Officer on the amount of time it takes for a Cat I pilot to become a HAC (HC-3b 2001).

$hday_h$: Similar to $pday_k$, the sequence day of helicopter production provides a means to map the final production date of a helicopter (a point in time) to a time interval that covers the entire planning horizon.

$helos_h$: The number of helicopters produced at the end of each production month by Sikorsky is set by contract and is tracked by a PMA 299 spreadsheet (NAVAIR 2001b).

$hsply_t$: A new helicopter is shipped from Sikorsky when it becomes available on the $hday_h$ that its production is complete at the plant.

$hmax_s$: The total number of helicopters each squadron is allowed to have has already been set based upon operational requirements and is obtained from the FIT (FIT 2001a).

$helopds_s$, $pcspds_s$, $tourpds_{\bar{c},\hat{c},s}$: These derived data provide a means to express travel time for helicopters and pilots as well as tour lengths for pilots in time periods rather than days. The integer portion of each value is used after adding half of a period to account for rounding errors. An additional period is added to the travel times to indicate that a helicopter or pilot is available during the period following the pilot's last traveling period.

IV. RESULTS

This chapter presents and compares OTHCAM's results with the distribution plan currently proposed by the FIT.

A. COMPUTER IMPLEMENTATION

OTHCAM is implemented in the commercial optimization software package GAMS (General Algebraic Modeling System), revision 117 (GAMS 1997a) using the OSL version 1 solver (GAMS 1997b). The model has been run once for each $\alpha \in \{0.0, 0.1, 0.2, ..., 1.0\}$, this gives the decision maker the flexibility to weigh the importance of one aspect of the composite objective function more than the other, as desired. As the composite objective function places more emphasis on lost helicopter fly days and less emphasis on lost pilot fly days with each successive run of the model (α increases from 0 to 1), a field of eleven optimal solutions is created. However, the solutions are essentially equivalent except for the extreme values of $\alpha = 0$ (only lost pilot fly days) and $\alpha = 1$ (only lost helicopter fly days). Therefore, in what follows, only results for $\alpha = 0.5$ are reported.

Over the duration of the planning horizon with a fidelity of 10-day periods, this GAMS solution using $\alpha = 0.5$ generates 10,027 equations, 12,023 variables, and 208,060 non-zero elements. The relative integrality gap, which is the difference between the current objective function upper bound and lower bound divided by the lower bound, is 11.3%. The upper bound is the value of the best integer solution found to that point, and the lower bound is derived from restrictions of the linear program relaxation of the model. Given the coarseness of the data, the integer solution is deemed adequate. OTHCAM identifies this solution in about 5 minutes using a Pentium III, 667 MHz computer with 128-megabytes of random access memory.

B. DIFFERENCES BETWEEN OTHCAM AND THE FIT SOLUTIONS

The OTHCAM solution is shown in Appendices C and D; the FIT solution is shown in Appendices A and E for comparison

The distribution plans proposed by OTHCAM and the FIT are difficult to compare for several reasons. The primary difficulty is that the two solutions pursue different objectives. The FIT's main concern is distributing aircraft to the fleet according to a self-defined hierarchy of mission requirements. The FIT is interested in sending MH-60S helicopters to HC-5 and then HC-6 before the other two active duty HC squadrons receive any new helicopters. This will allow these two squadrons to support MH-60S detachments first. According to the FIT, these squadrons are to be transitioned to the MH-60S as completely as possible before the fixed retirement date of the H-46 airframes in June 2004. Furthermore, the FIT wants to minimize the amount of time a squadron is transitioning to the MH-60S; therefore their plan encourages allocation of blocks of new aircraft to one squadron at a time (FIT 2001b). In contrast, OTHCAM's objective is to minimize lost helicopter and pilot fly days. Helicopters are distributed to find the optimal solution for that measure of effectiveness without regard for the squadron transition priorities established by the FIT.

The FIT plan distributes an MH-60S helicopter to an HC squadron and then allocates a complete detachment of pilots to that squadron to fly the aircraft (FIT 2001b). Appendix E shows the FIT distribution of pilots. For the most part, this distribution of pilots is done without regard to the most efficient pairing of pilot types based on the date the students complete the FRS. This results in near-continuous condition of helicopters waiting for MH-60S trained crews to arrive at the squadron. OTHCAM encourages the distribution of pilots to a particular squadron in half detachments in order to decrease the number of lost helicopter and pilot fly days, but does not constrain the solution to distribute FRS graduates in defined blocks of detachment size.

OTHCAM uses the published Prospective Squadron Manning Documents as a guideline for determining pilot distribution. The FIT did not use this resource to resolve the number of each type of pilot that a particular squadron should have.

OTHCAM has a time fidelity expressed in 10-day periods. The FIT spreadsheet rounds all time-sensitive data to the nearest month, allowing a less exact solution.

OTHCAM accounts for the approximate number of aircraft commanders in each squadron by "promoting" category I pilots to category II pilots after a reasonable length of time in their fleet squadron. The FIT acknowledges that the number of aircraft commanders in each squadron will change as category I pilots become HACs, but they do not attempt to track these numbers.

OTHCAM allocates helicopters to the fleet squadrons as soon as the helicopters are produced. The FIT plan sometimes does not allocate a helicopter during the month it is produced; rather, the plan may allow the helicopter to sit idle for distribution later. For example, referring to October of FY 2002 in Appendix A, Sikorsky completes two MH-60S aircraft, but the FIT distribution plan does not send them to anyone. Conversely, in December of FY 2002, four MH-60S aircraft are sent to the fleet even though only two are produced that month. While the FIT does eventually distribute the correct number of aircraft each squadron is scheduled to receive, significant idle time accrues for those aircraft that are pooled in inventory. To allow OTHCAM and the FIT results to be compared to each other, the FIT distribution of helicopters was amended slightly to match Sikorsky's production schedule; see Table 7. The changes to the FIT distribution schedule only apply to the first fourteen months of their plan and still allocate the correct number of aircraft to the HC squadrons.

Fiscal Year of Production		Fiscal Year 2002												FY 2003	
Month of Production		O	N	D	J	F	M	A	M	J	J	A	S	O	N
Number of Aircraft Produced		2	2	2	2	1	2	2	1	1	1	1	1	1	2
Squadrons Aircraft are Distributed To	Total Aircraft Allocated to Squadron														
HC-5	**14**	2	2	2		1			1	1			1		
HC-6	**16**				2		2	2			1	1		1	1
HC-8	**16**														1
HC-11	**23**														

Table 7. Amended FIT Distribution of MH-60S Aircraft
This table shows only the amended portion of the FIT distribution, which now allocates the same number of MH-60S aircraft as are produced in a given month. The initial four aircraft sent to HC-5 during LRIP production are not shown in this table. The total number of airframes distributed to each squadron by November of FY 2003 is the same for the original FIT plan and the amended distribution.

OTHCAM does not address distribution of helicopters to any squadron other than the active duty HC squadrons per guidance from the sponsor of this thesis, PMA 299. The FIT plan includes allocation of MH-60S aircraft to numerous types of squadrons that will fly the new aircraft including the HC FRS at HC-3, reserve HC squadrons, the mine warfare (HM) helicopter squadrons, and other commands (NAVAIR 2001b). The distribution of MH-60S-trained pilots to these same squadrons is not addressed in the FIT plan. This allocation of helicopters lengthens the time to distribute all MH-60S aircraft required by the four active duty HC squadrons in the FIT plan. The final MH-60S to be delivered to an active duty HC squadron occurs in September of FY 2008 in the FIT plan, compared to June of FY 2005 for OTHCAM. OTHCAM assumes that the additional squadrons will receive MH-60S airframes after the active duty HC squadrons have received their full allocation of aircraft. To compare the FIT plan to OTHCAM, the data for Sikorsky's production schedule has been changed to exclude those aircraft that are scheduled by the FIT to go to any squadron other than the four active duty HC squadrons in their solution.

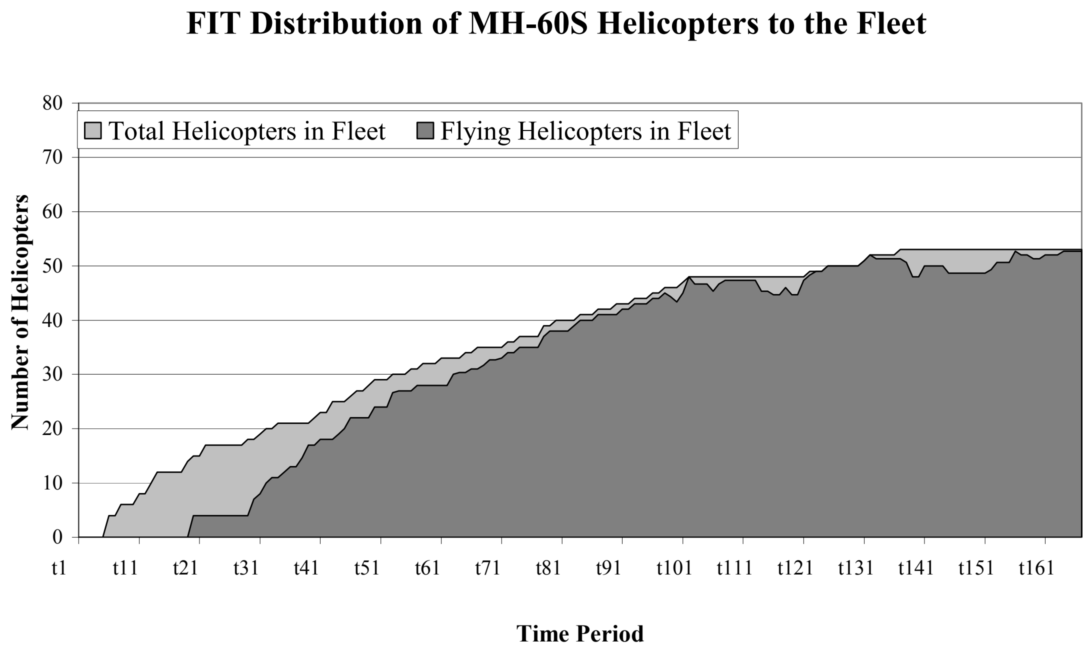
C. ADDITIONAL EFFORT

The FIT declares that operational and contractual constraints require the distribution of MH-60S aircraft according to their plan until the mandatory retirement of the H-46 airframes in June 2004. However, the distribution of MH-60S aircraft produced after this date is still potentially discretionary. Although the additional constraints required by the FIT are not considered essential by the sponsor of this thesis, these constraints have been incorporated into a version of OTHCAM in order to convince the FIT of OTHCAM's viability. The constraints are added by fixing helicopter distribution to match the FIT plan until July 2004. However, FRS graduate distribution has been left as variable for the entire planning horizon of the model since this constraint has not been requested by the FIT. The optimal distributions of helicopters and FRS graduates to the active duty HC squadrons proposed by this supplementary version of OTHCAM are shown in Appendices F and G, respectively.

D. GRAPHICAL COMPARISON OF THE NUMBER OF LOST FLY DAYS ALLOWED BY OTHCAM AND THE FIT SPREADSHEET PLAN

The distribution schedule suggested by OTHCAM results in a reduction in the number of lost helicopter and pilot fly days of 26% when compared to the FIT plan over the planning horizon available for the given data. Most of the improvement is in lost helicopter fly days: this is expected since the FIT plan assigns a complete MH-60S trained detachment only after a helicopter has been distributed to a given squadron. Once a pilot has completed his tour at an assigned squadron, the FIT plan occasionally has difficulty replacing that pilot type because of requirements by other squadrons to receive full detachments of pilots. This results in further accumulation of lost helicopter fly days. Furthermore, even after incorporating the additional constraints concerning initial helicopter distribution requested by the FIT, OTHCAM suggests a distribution that is 22% more efficient than the FIT spreadsheet plan.

It is difficult to directly compare the number of lost fly days allowed by OTHCAM and the FIT plan because the FIT spreadsheet uses a planning horizon that is more than three years longer than the data available for FRS classes. In order to compensate for this situation, OTHCAM's planning horizon has been used to provide a common baseline. This actually makes the FIT plan appear more competitive with OTHCAM than if the FIT's entire planning horizon is used. The FIT plan actually becomes less efficient after the end of the OTHCAM horizon because it begins to distribute most of the helicopters produced to squadrons other than the four active duty HC squadrons, resulting in an increasing number of lost fly days. The following figures provide a graphical depiction of these results. Light gray indicates lost fly days in all of the graphs shown.



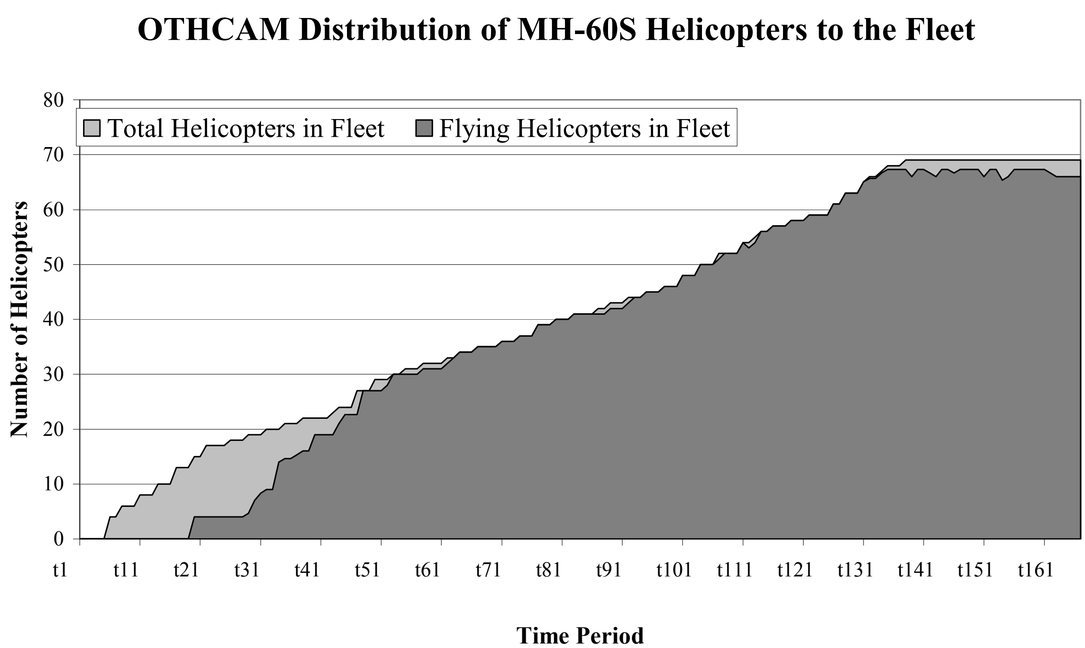
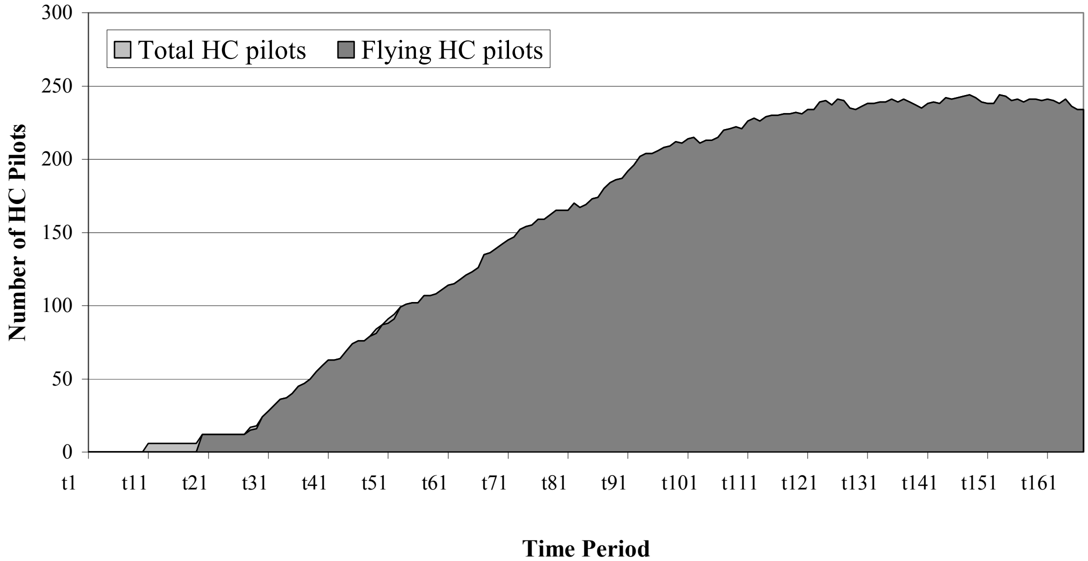


Figure 4. Comparison of the OTHCAM and FIT Distributions of MH-60Ss to All of the HC Squadrons

Note that OTHCAM distributes all 69 MH-60S helicopters during the planning horizon, but the FIT plan does not. Both have unflyable helicopters at the beginning of the planning horizon because the first class of MH-60S trained pilots does not graduate the FRS until more than seven months after the first helicopter is delivered from Sikorsky. The small “shelf” of flyable helicopters after time period 21 results from the initial cadre of pilots that complete the MH-60S IOC. OTHCAM’s graph shows almost perfect utilization of helicopters after the initial shortfall of trained pilots is overcome. The lost fly days OTHCAM accumulates at the end of the planning horizon are caused by the large number of helicopters allocated to HC-11, which does not have adequate pilots available according to the PSQMDs.

FIT Distribution of MH-60S Trained HC Pilots to the Fleet



OTHCAM Distribution of MH-60S Trained HC Pilots to the Fleet

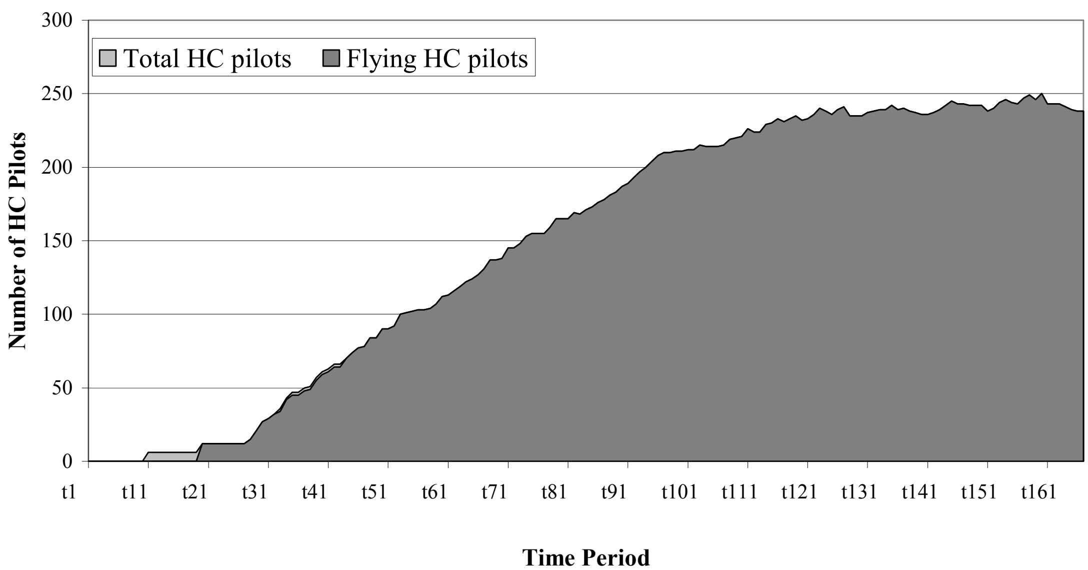
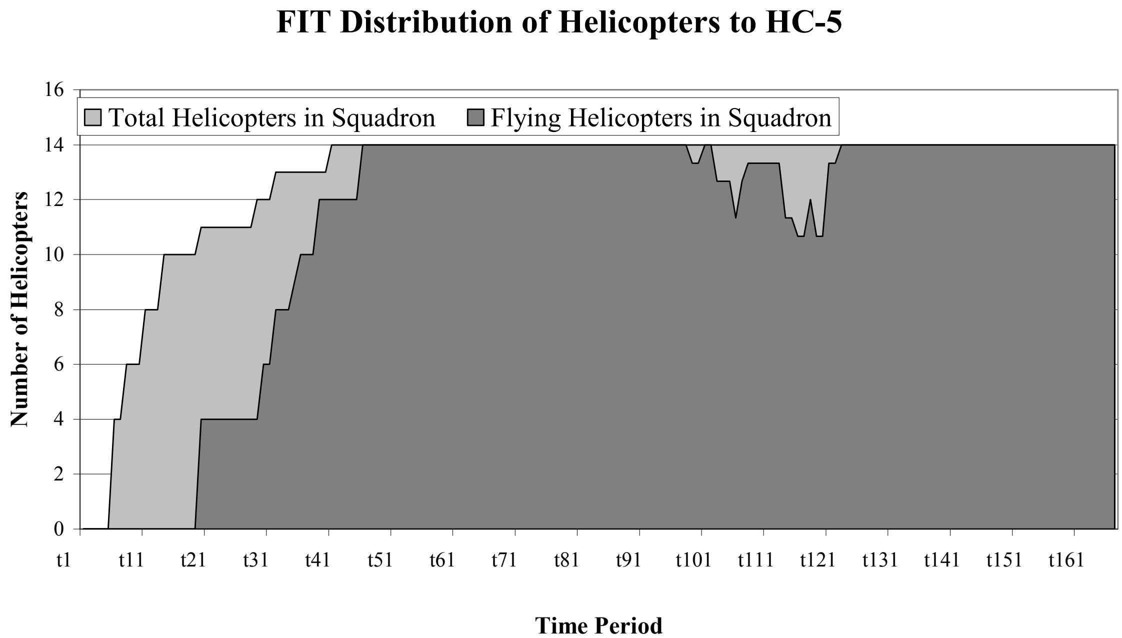


Figure 5. Comparison of the OTHCAM and FIT Distributions of Pilots to All of the HC Squadrons

One can see from the absence of light gray in these graphs that OTHCAM and the FIT plan utilize MH-60S trained pilots as efficiently as possible, even though their particular distribution of those pilots is different. These differences can be seen by comparing the results in appendices D and E. The FIT plan has a few more lost pilot fly days near time period fifty-one, but the two distributions are essentially equally effective. The initial group of unused pilots in both distributions is composed of the Cat IIs and OICs of the IOC cadre that are awaiting their complementary Cat I pilots to complete the FRS.



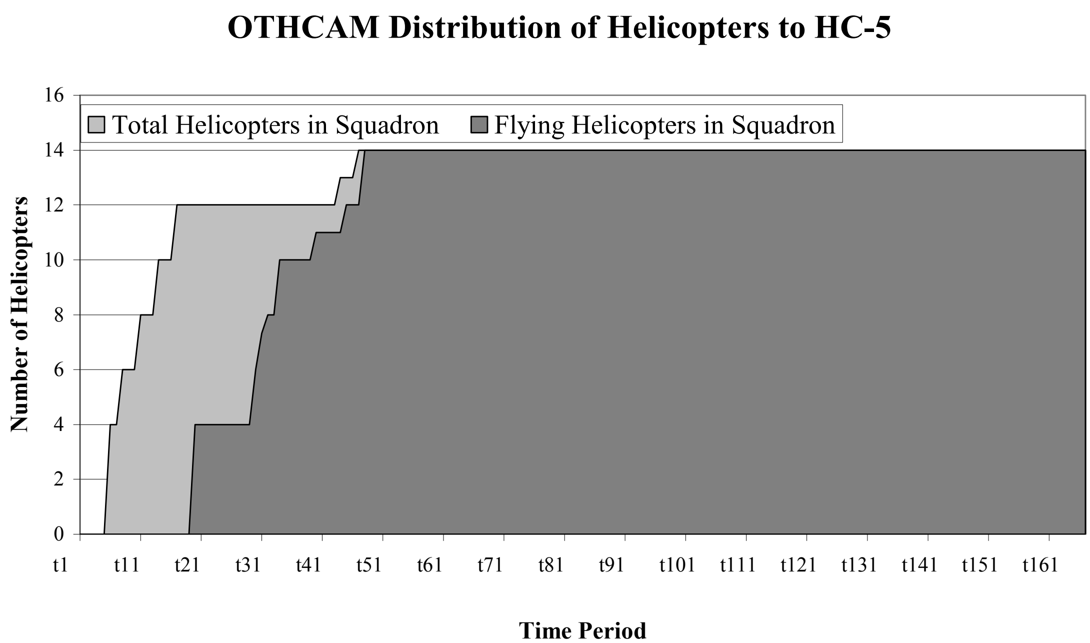
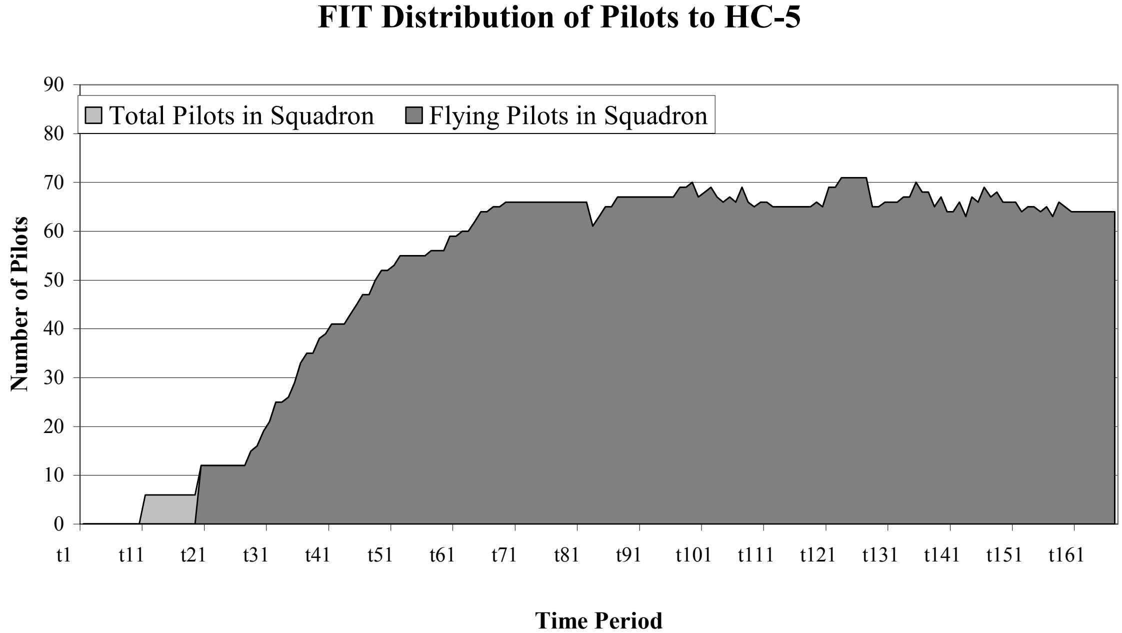


Figure 6. Comparison of the OTHCAM and FIT Distributions of MH-60Ss to HC-5 in Guam

Unlike most of the active duty HC squadrons in the FIT plan, HC-5 receives its full allocation of MH-60S aircraft within OTHCAM's planning horizon. The two distributions are comparable until about time period 101 (the first week of July in FY 2004). At that time, the FIT spreadsheet begins accumulating lost helicopter fly days. This is because the population of Cat Is in HC-5 begins to shrink because of their tours ending, but all of the available Cat Is are being sent to HC-11. OTHCAM distributes replacement pilots in a manner that prevents this.



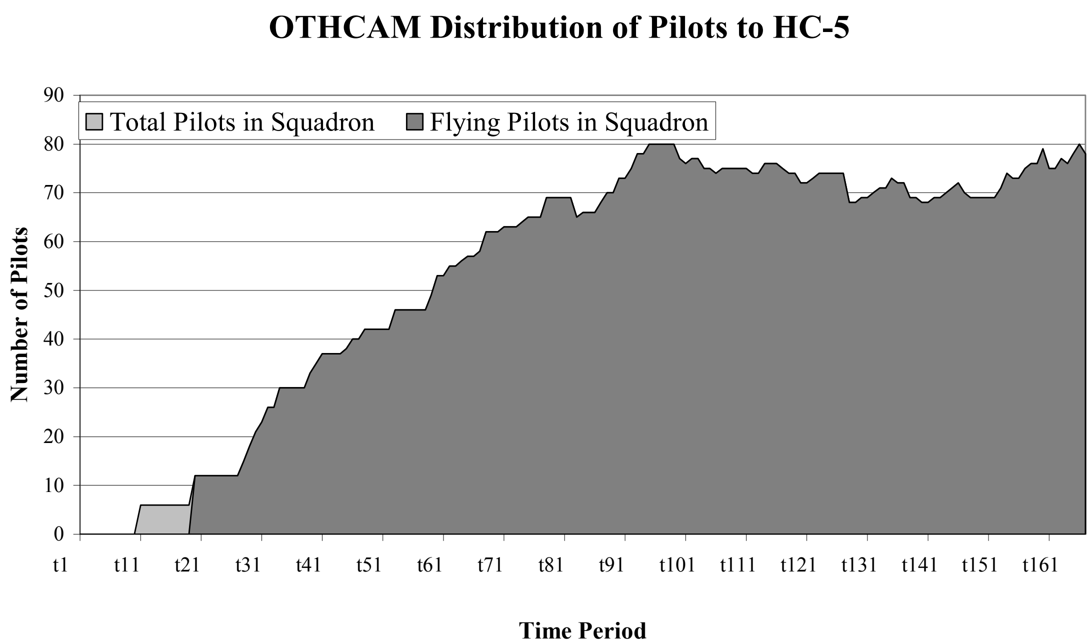


Figure 7. Comparison of the OTHCAM and FIT Distributions of Pilots to HC-5 in Guam

The initial presence of lost pilot fly days in both OTHCAM and the FIT distributions results from the IOC cadre of pilots that are sent to HC-5. The most significant difference in the two distributions is the total pilot population in the squadron beginning near time period 101 (the first week of July in FY 2004). The FIT plan maintains about 65 pilots in the squadron. OTHCAM recognizes that fewer pilots are required in HC-5 to prevent the accumulation of lost fly days and diverts new FRS graduates to other squadrons, allowing the pilot population in HC-5 to decrease.

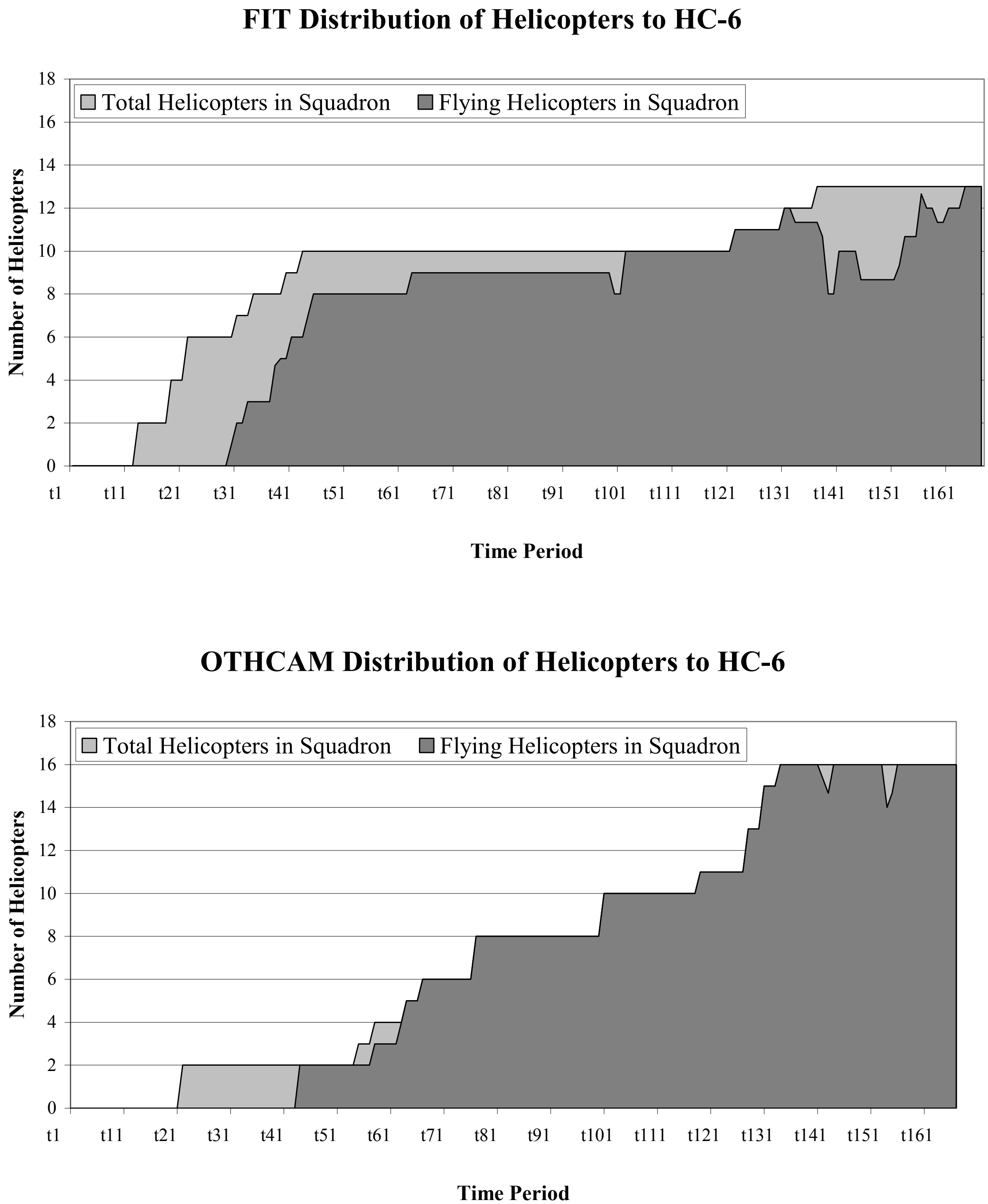
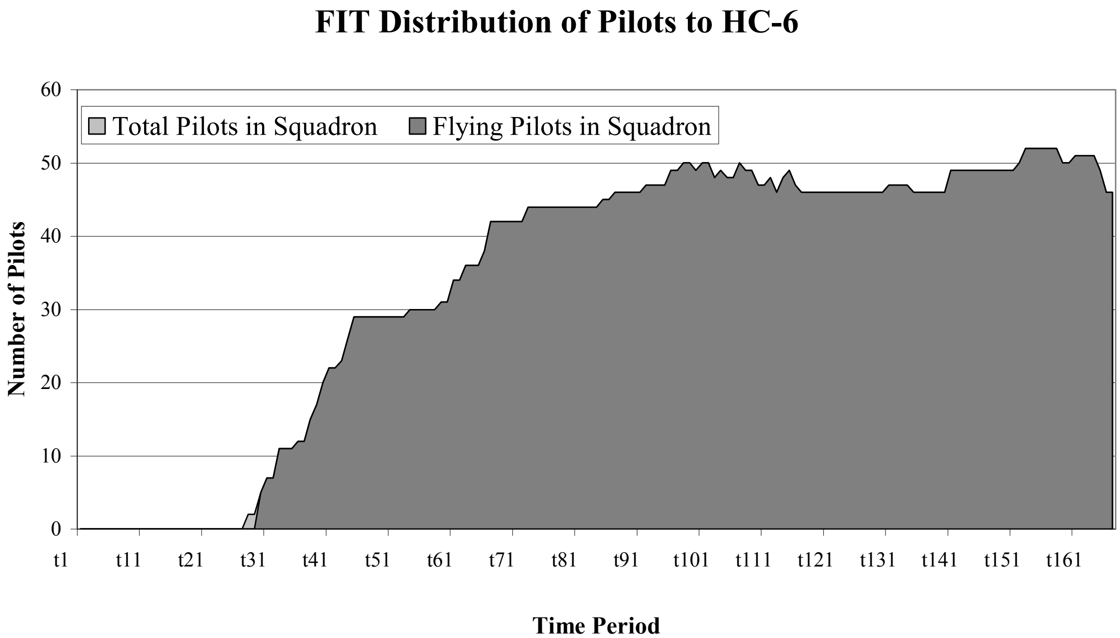


Figure 8. Comparison of the OTHCAM and FIT Distributions of MH-60Ss to HC-6 in Norfolk

The largest discrepancy between OTHCAM and the FIT plans is the allocation of helicopters to HC-6. This is the first example of how the FIT plan does not distribute all of the helicopters required by a squadron during OTHCAM's planning horizon. Only 12 of the 16 aircraft allocated to HC-6 are delivered by the FIT plan. Despite the relative abundance of available pilots compared to helicopters, the FIT plan suffers from significant lost helicopter fly days compared to OTHCAM. Almost all of OTHCAM's lost fly days are in the initial squadron buildup phase.



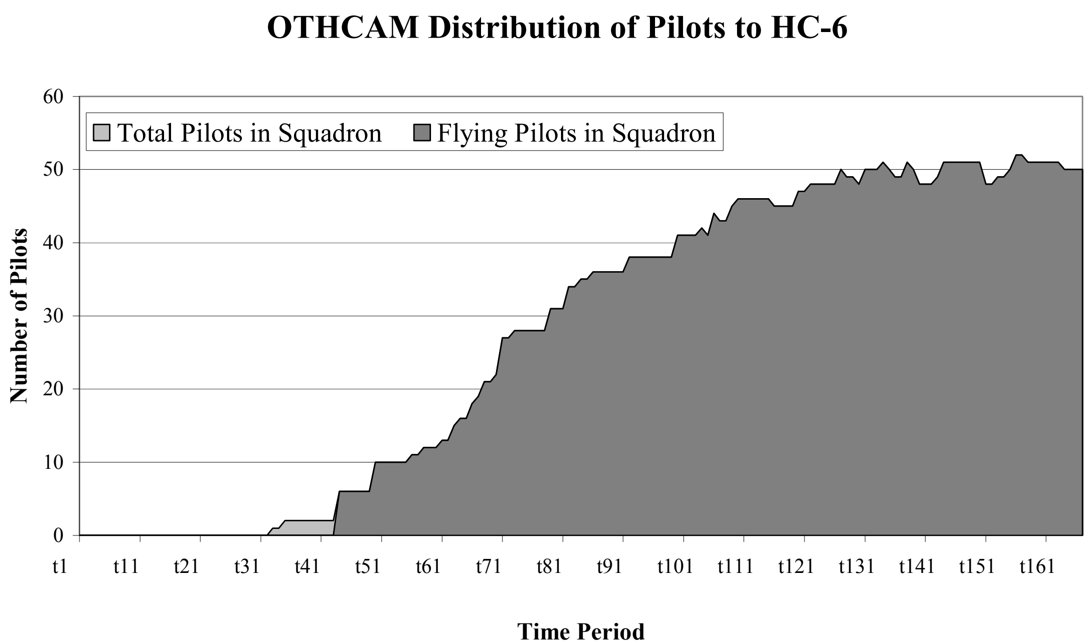
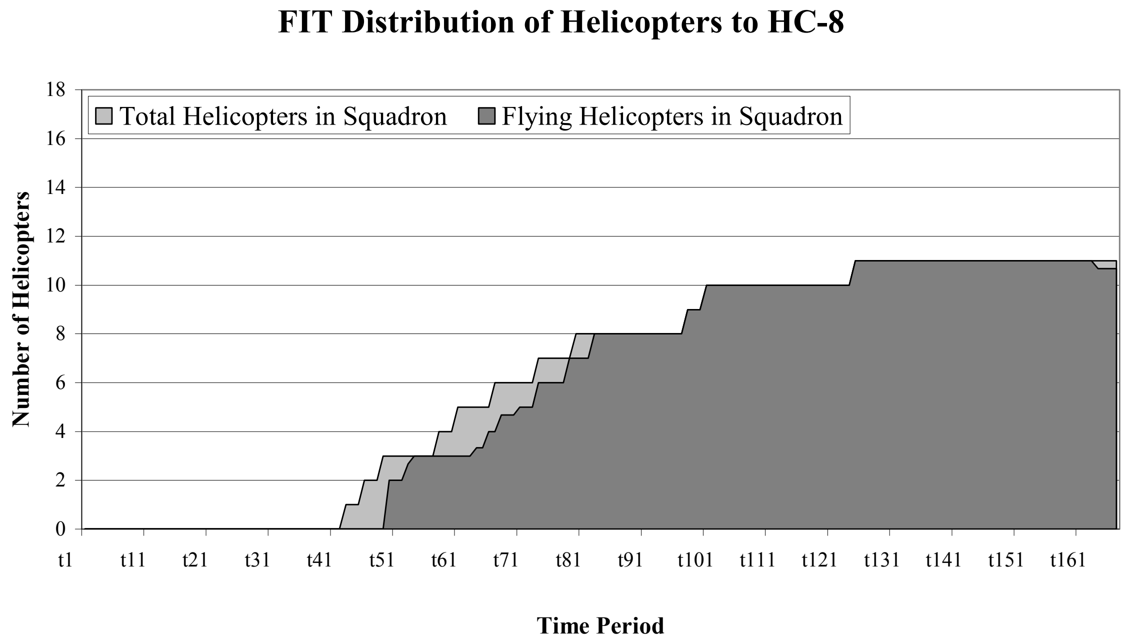


Figure 9. Comparison of the OTHCAM and FIT Distributions of Pilots to HC-6 in Norfolk

Once again, both distributions have very few lost pilot fly days for the individual squadrons, in this case, HC-6. Initially, OTHCAM incurs a significant number of lost pilot fly days because of the presence of a handful of Cat II pilots without any complementary Cat I or OIC pilots. While these pilots could actually fly the MH-60S aircraft that are sent to HC-6, these aircraft are considered unflyable according to the required manning definition adopted by this thesis. If it is unacceptable for these few Cat II pilots to arrive at HC-6 almost 100 days before any other MH-60S pilots arrive, they could be sent elsewhere.



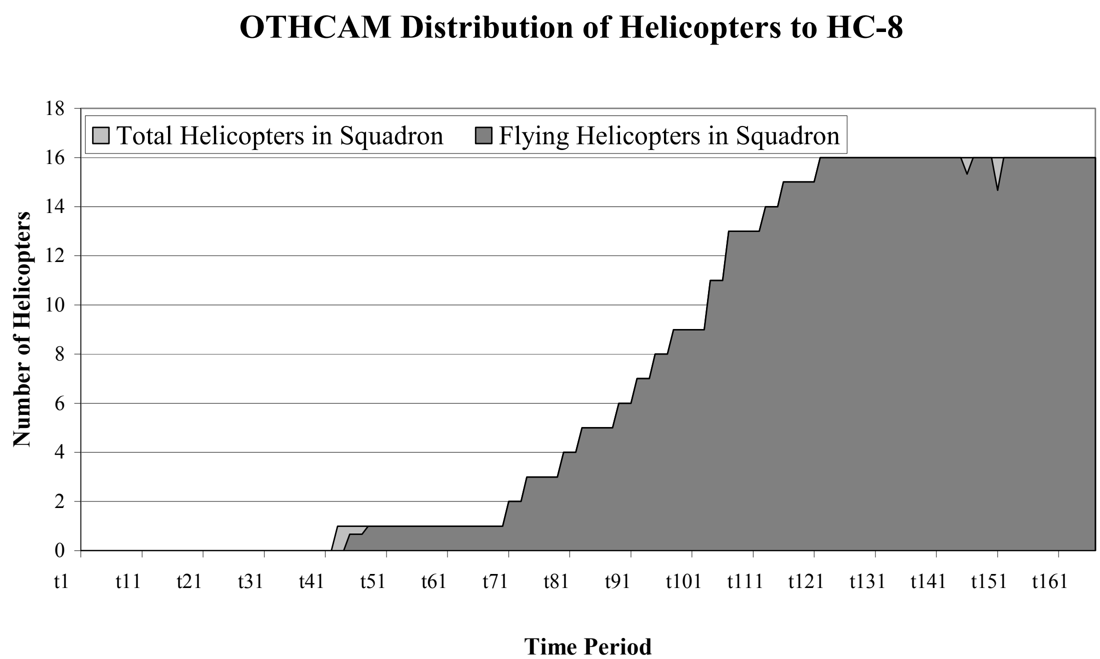
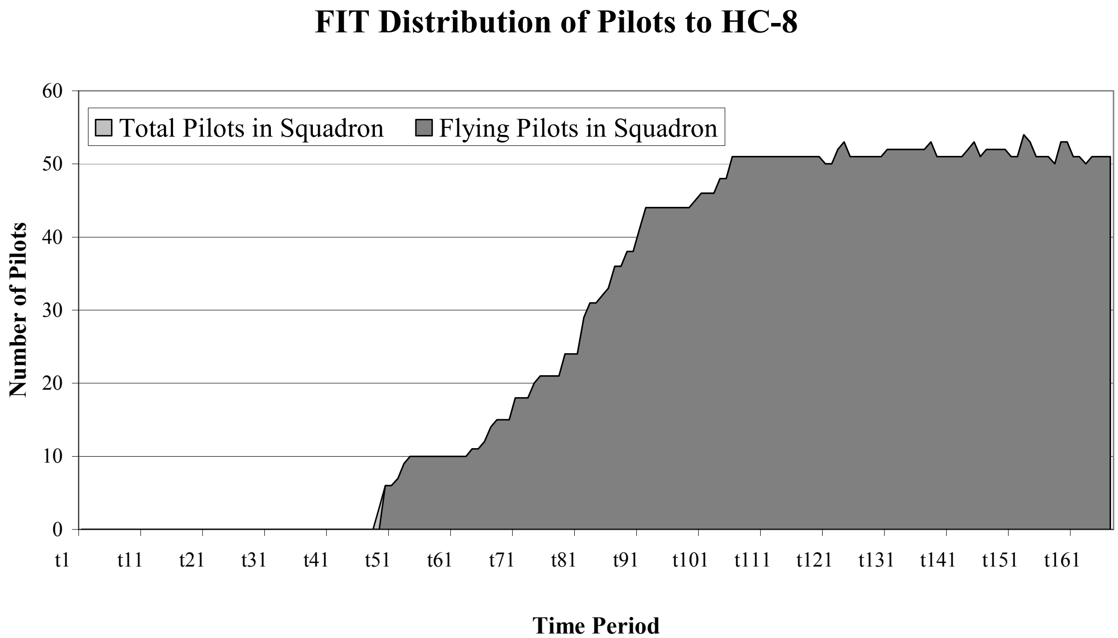


Figure 10. Comparison of the OTHCAM and FIT Distributions of MH-60Ss to HC-8 in Norfolk

HC-8 is another example of the FIT plan failing to distribute a squadron's full allocation of aircraft during OTHCAM's planning horizon. Once again, the FIT plan accumulates many more lost helicopter fly days than OTHCAM despite its relatively large number of available pilots. OTHCAM does maintain only one MH-60S helicopter in HC-8 for almost 300 days. This would preclude that squadron from deploying a standard detachment of two helicopters until the next aircraft arrives near time period 71 (the second week of September in FY03).



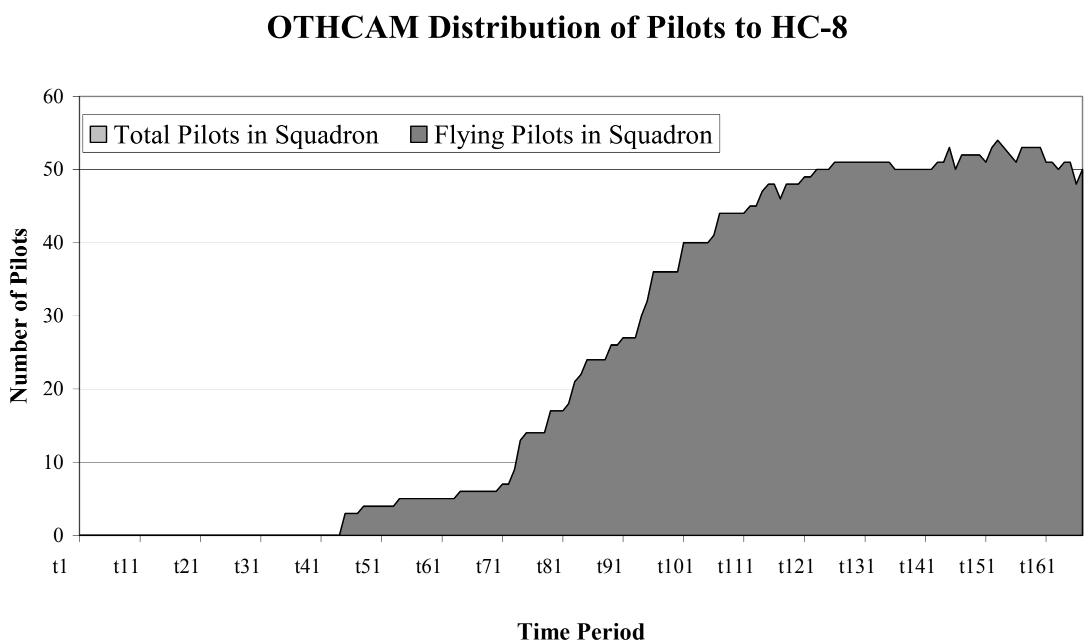
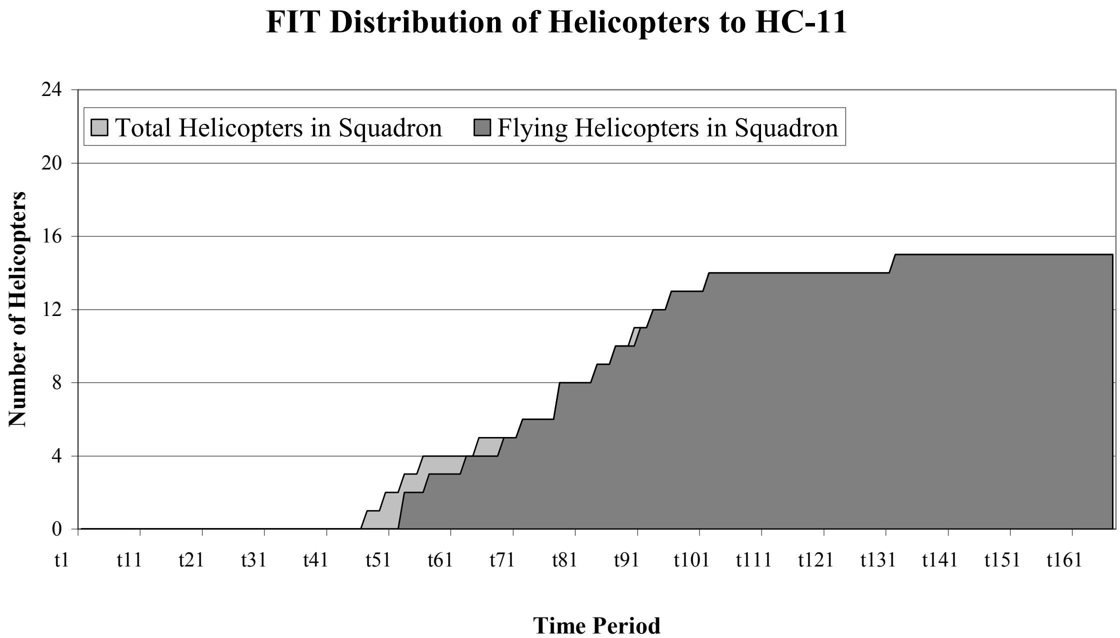


Figure 11. Comparison of the OTHCAM and FIT Distributions of Pilots to HC-8 in Norfolk

Despite the large variation between the OTHCAM and FIT distributions of pilots and helicopters to HC-8, both almost fully utilize the pilots on hand. The FIT plan has a few lost pilot fly days initially, but the two are essentially equivalent in their lack of lost pilot fly days.



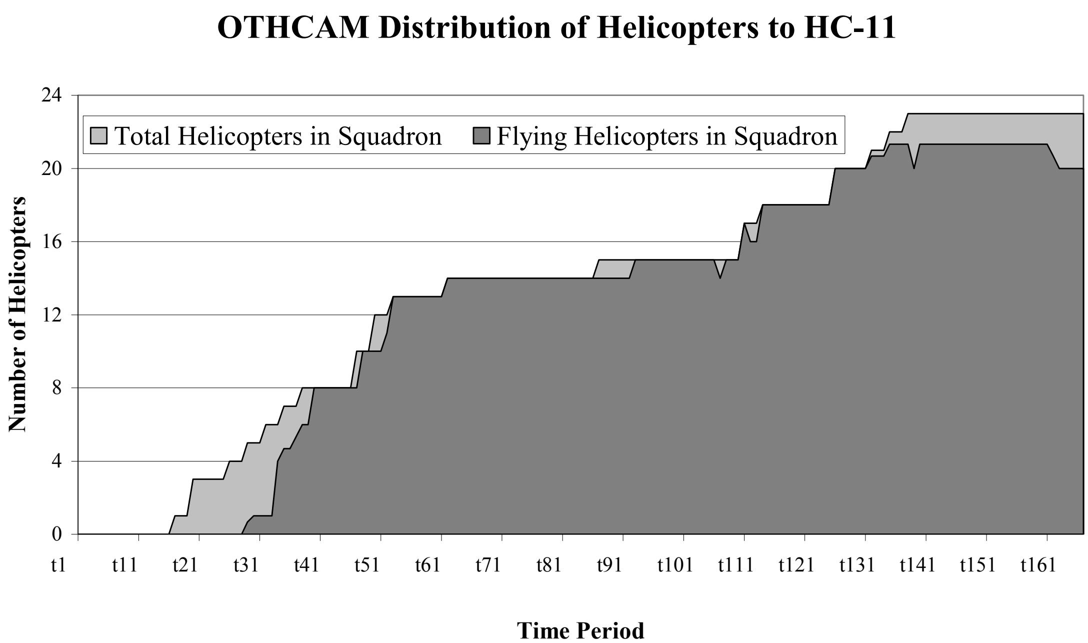
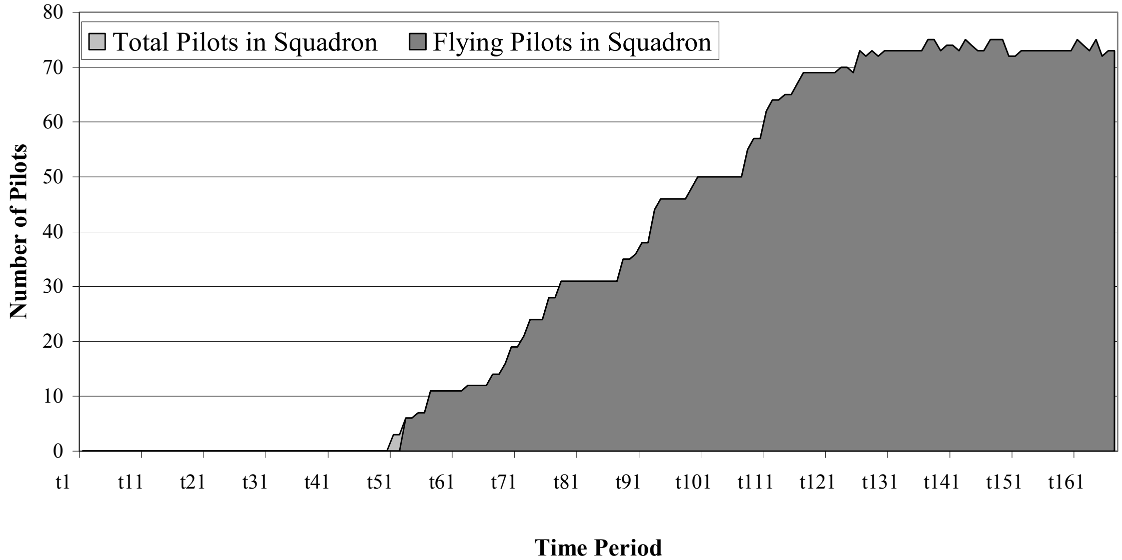


Figure 12. Comparison of the OTHCAM and FIT Distributions of MH-60Ss to HC-11 in San Diego

HC-11 is the only instance in which OTHCAM accumulates more lost helicopter fly days than the FIT plan during the planning horizon shown. Of course, OTHCAM has distributed all of HC-11's 23 helicopters during this time while the FIT plan has only delivered 15. The FIT spreadsheet will certainly accumulate more lost helicopter fly days beyond OTHCAM's planning horizon since it does not deliver HC-11's last helicopter until September of FY 2008. The lost helicopter fly days observed on the first graph for the entire HC fleet is caused by this abundance of helicopters in HC-11.

FIT Distribution of Pilots to HC-11



OTHCAM Distribution of Pilots to HC-11

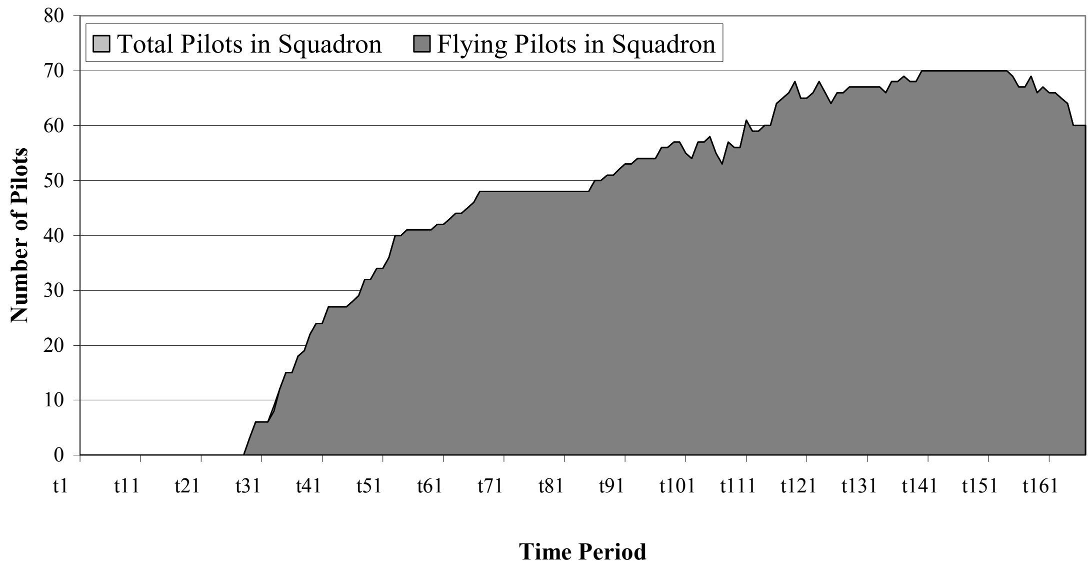
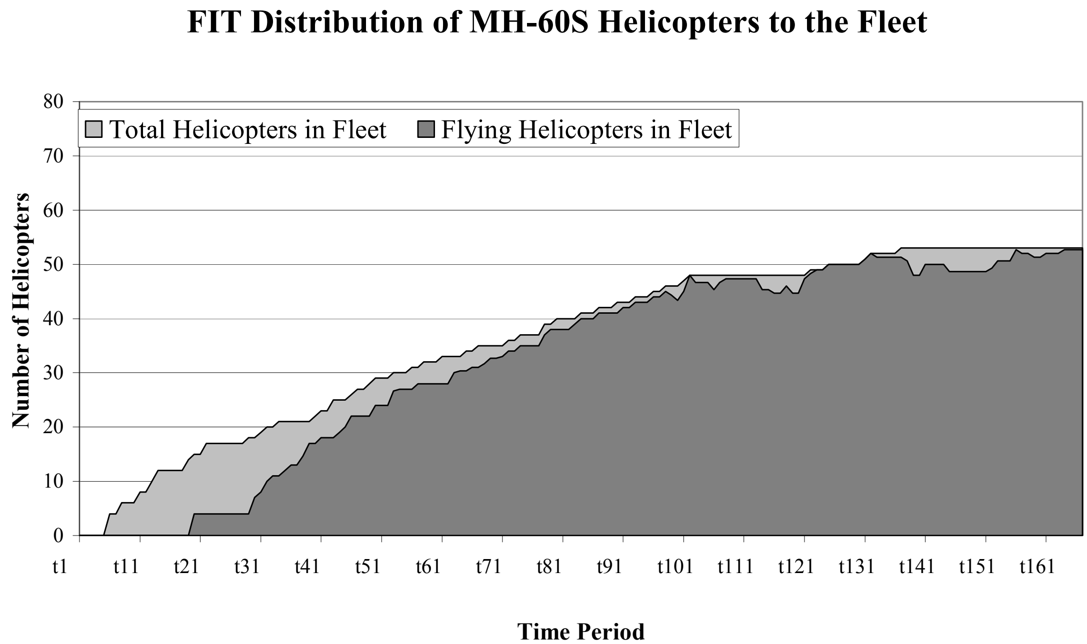


Figure 13. Comparison of the OTHCAM and FIT Distributions of Pilots to HC-11 in San Diego

Similar to the results for HC-8, OTHCAM perfectly utilizes all of the pilots sent to HC-11, while the FIT plan initially accumulates a few lost pilot fly days. However, this number of unused pilots is very small, making the number of lost pilot fly days allowed by the two distributions very similar. HC-11 is by far the largest squadron in terms of helicopters, but does not have the largest population of pilots (NAVAIR 1998). This results in the large number of lost helicopter fly days OTHCAM accumulates near the end of the planning horizon (see Figures 4 and 12), which the FIT plan will not encounter until much later.



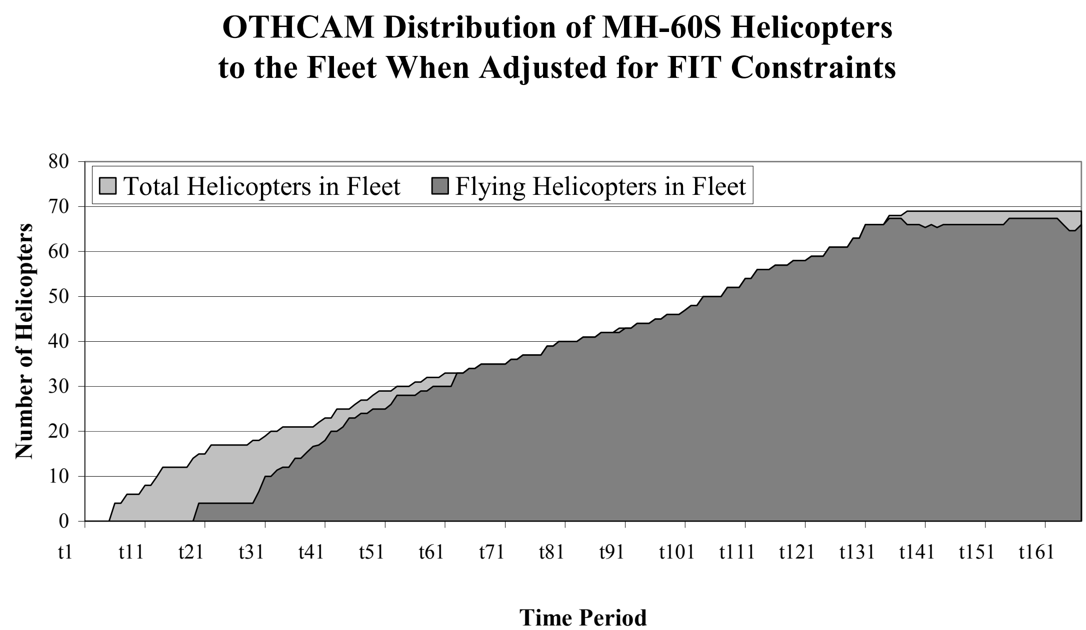
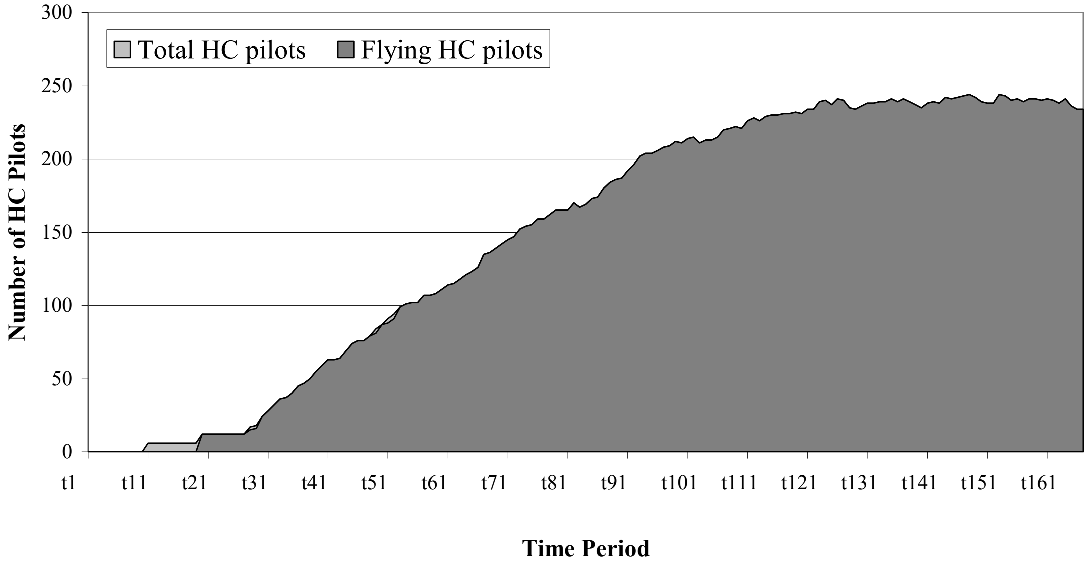


Figure 14. Comparison of the OTHCAM and FIT Distributions of MH-60Ss to All of the HC Squadrons After Restricting OTHCAM with Additional FIT Constraints

Once again, OTHCAM distributes the full complement of 69 aircraft within the planning horizon allowed by the data, but the FIT plan has not. This supplemental version of OTHCAM also shows an initial accumulation of lost helicopter fly days as the delayed supply of pilots from the FRS attempts to catch up with the supply of helicopters. However, OTHCAM again overcomes this shortfall and eliminates lost fly days while the FIT plan continues to accumulate them. The appearance of lost helicopter fly days towards the end of the planning horizon is once more caused by the abundance of helicopters allocated to HC-11.

FIT Distribution of MH-60S Trained HC Pilots to the Fleet



OTHCAM Distribution of MH-60S Trained HC Pilots to the Fleet When Adjusted for FIT Constraints

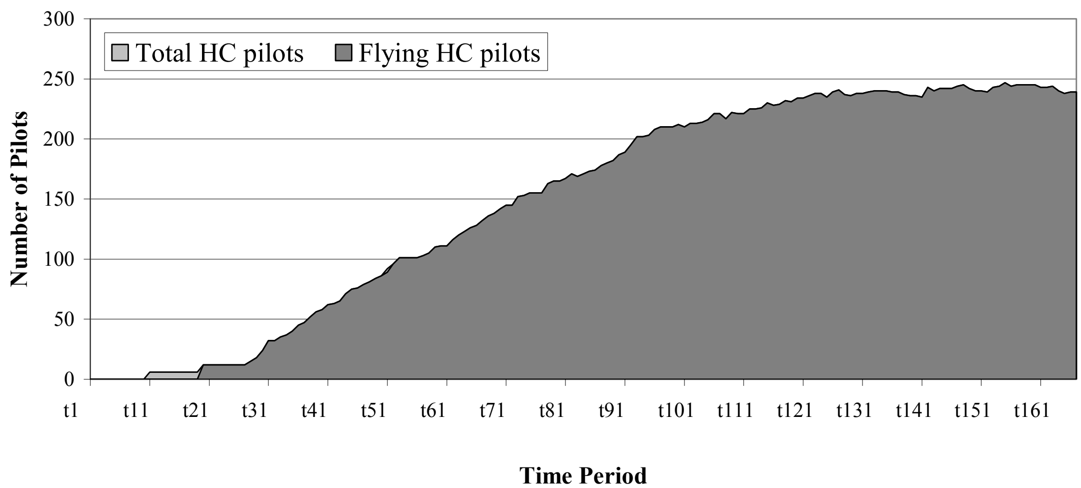


Figure 15. Comparison of the OTHCAM and FIT Distributions of Pilots to All of the HC Squadrons After Restricting OTHCAM with Additional FIT Constraints

The accumulation of lost pilot fly days for both plans is essentially zero and equivalent for this adaptation of OTHCAM and the FIT plan, just as it was for the original version of OTHCAM. However, results shown in appendices E and G indicate that the specific distribution of pilots is once again very different.

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V. CONCLUSIONS

The sponsor of this thesis, PMA 299, requested a solution prior to the completed production of the first unclaimed MH-60S aircraft on 31 October 2001. OTHCAM was successfully run and results were forwarded to PMA 299 on 15 October. At that time, PMA 299 reported that the initial MH-60S FRS class start date would be delayed for roughly three months. These updated data were incorporated into the model, which produced the results presented in this thesis. These results were sent not only to PMA 299 on 19 October, but also to the FIT on 5 November for their comment. The FIT requested clarification of some of the assumptions made in the OTHCAM model, which were explained over a series of email messages and phone calls. Some additional constraints concerning the initial distribution of helicopters to certain squadrons were considered vital to the FIT and incorporated into a version of OTHCAM. The results from this adaptation of OTHCAM were sent to PMA 299 on 9 December. Although these additional constraints were not considered essential by PMA 299, OTHCAM was run using them to convince the FIT of the model's validity and to help validate the FIT plan. The FIT has since updated its spreadsheet plan.

The accumulation of lost fly days is wasteful in terms of training opportunities and manpower costs. OTHCAM provides a distribution of helicopters and pilots that meets operational objectives and minimizes lost fly days. It is recommended that the U.S. Navy utilize the results from one of the two versions of OTHCAM, depending upon the necessity of the additional FIT constraints. In both cases, OTHCAM provides the most effective allocation of MH-60S helicopters and FRS graduates to the active duty HC squadrons.

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APPENDIX A. FIT DISTRIBUTION OF MH-60S HELICOPTERS TO THE FLEET

Fiscal Year of Production		Fiscal Year 2002												Fiscal Year 2003											
Month of Production		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Number of Aircraft Produced		2	2	2	2	1	2	2	1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	1	1
Squadrons Aircraft are Distributed To	Total Aircraft Allocated to Squadron																								
HC-5	14		2	2				2	2	2		2	2												
HC-6	16			2				2	2			2			2										
HC-8	16														1	1	1			1	1		1		1
HC-11	23															1	1	1	1			1		1	

Fiscal Year of Production		Fiscal Year 2004												Fiscal Year 2005											
Month of Production		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Number of Aircraft Produced		2	1	1	1	1	1	1	1	2	2	2	2	2	1	1	1	2	2	3	2	2	2	2	2
Squadrons Aircraft are Distributed To	Total Aircraft Allocated to Squadron																								
HC-5	14																								
HC-6	16																1			1		1			
HC-8	16		1						1	1								1					1		
HC-11	23	2		1	1	1	1	1		1										1			1		
HC-85	8										2	2	2	2											
HC-3	17																	1		1		1			
HM-14	16														1	1			2		2			2	
HS-10	2																								2

Table 1. The First Four Years of the FIT Distribution of MH-60S Helicopters. The initial four aircraft sent to HC-5 during LRIP are not shown in this table, but are included in the 14 aircraft the squadron is allocated. As mentioned in part C of the Results chapter, this table clearly shows how the FIT plan does not always distribute the same number of MH-60S helicopters as are produced in a given month. There are several instances in FY02 when helicopters are not delivered to any squadron even though Sikorsky produces some that month, as well as more helicopters being sent to squadrons than are completed by Sikorsky. This table also begins to show the large number of squadrons that the FIT plan distributes MH-60S helicopters to besides the four active duty HC squadrons.

Fiscal Year of Production		Fiscal Year 2006												Fiscal Year 2007											
Month of Production		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Number of Aircraft Produced		2	1	1	1	1	2	1	2	1	2	2	2	2	1	1	1	1	2	1	2	1	2	2	2
Squadrons Aircraft are Distributed To	Total Aircraft Allocated to Squadron																								
HC-5	14																								
HC-6	16		1									1		1											
HC-8	16	1		1									1					1							
HC-11	23	1					1														1			1	
HC-3	17						1															1		1	
HCS-4	8																								2
HCS-5	8													1	1				2	1	1		2		
HM-14	16				1	1		1	2		1	1	1												
HS-2	2									1	1														
HS-3	2															1	1								

Fiscal Year of Production		Fiscal Year 2008											
Month of Production		O	N	D	J	F	M	A	M	J	J	A	S
Number of Aircraft Produced		2	1	1	1	1	2	1	2	1	2	2	1
Squadrons Aircraft are Distributed To	Total Aircraft Allocated to Squadron												
HC-5	14												
HC-6	16												
HC-8	16												
HC-11	23								1			1	1
HC-3	17											1	
HS-75	2	2											
HCS-4	8		1	1	1		1	1	1				
HS-4	2					1	1						
NSWAC	3									1	2		

Table 2. The Last Three Years of the FIT Distribution of MH-60S Helicopters. The FIT plan allocates a larger percentage of MH-60S helicopters to squadrons other than the four active duty HC squadrons after OTHCAM's planning horizon ends in June of FY05. This is the reason why the FIT plan has a planning horizon that extends beyond the data available for MH-60S FRS classes.

APPENDIX B. FRS CLASSES AND START DATES

FRS class # 0---	type pilot	class start date
207	c2	**21-Jan-02**
	c2	
	oic	
	c1	
	c1	
	c1	
208	c2	**4-Feb-02**
	c2	
	oic	
	c1	
	c1	
	c1	
209	c2	**19-Feb-02**
	oic	
	c1	
	c1	
	c1	
210	c2	**4-Mar-02**
	c2	
	oic	
	c1	
	c1	
	c1	
211	c2	**18-Mar-02**
	oic	
	c1	
	c1	
	c1	
212	c2	**8-Apr-02**
	c2	
	c2	
	c2	
	c1	
213	c2	**22-Apr-02**
	oic	
	c1	
	c1	
	c1	
214	c2	**6-May-02**
	c2	
	oic	
	c1	
	c1	
215	c2	**20-May-02**
	c1	
	c1	
	c1	
	c1	
	c1	

FRS class # 0---	type pilot	class start date
216	c2	**10-Jun-02**
	oic	
	c1	
	c1	
	c1	
217	c1	**24-Jun-02**
	c1	
	c1	
218	c2	**8-Jul-02**
	oic	
	c1	
	c1	
219	c2	**22-Jul-02**
	c2	
	oic	
	c1	
220	c2	**5-Aug-02**
	oic	
	c1	
	c1	
221	c1	**19-Aug-02**
	c1	
	c1	
	c1	
222	c2	**2-Sep-02**
	c2	
	oic	
	c1	
	c1	
223	c1	**16-Sep-02**
	c1	
	c1	
	c1	
301	c2	**7-Oct-02**
	oic	
	c1	
	c1	
302	c2	**21-Oct-02**
	c2	
	oic	
	c1	
303	oic	**11-Nov-02**
	c1	
	c1	
	c1	
304	c2	**25-Nov-02**
	c1	
	c1	
	c1	
	c1	

FRS class # 0---	type pilot	class start date
305	c1	**9-Dec-02**
	c1	
	c1	
	c1	
306	c2	**13-Jan-03**
	c2	
	oic	
	oic	
	c1	
	c1	
307	c2	**27-Jan-03**
	c2	
	c1	
	c1	
308	c2	**10-Feb-03**
	oic	
	c1	
	c1	
	c1	
	c1	
309	c2	**24-Feb-03**
	oic	
	c1	
	c1	
310	c2	**10-Mar-03**
	oic	
	c1	
	c1	
311	c1	**24-Mar-03**
	c1	
	c1	
	c1	
312	c2	**7-Apr-03**
	oic	
	c1	
	c1	
313	c2	**21-Apr-03**
	oic	
	c1	
	c1	
314	c2	**5-May-03**
	c2	
	oic	
	c1	
315	c1	**19-May-03**
	c1	
	c1	
	c1	
316	c1	**9-Jun-03**
	c1	
317	c2	**23-Jun-03**
	c2	
	c2	
	oic	
318	c1	**7-Jul-03**
	c1	
	c1	
	c1	
319	oic	**21-Jul-03**
	oic	
	c1	
	c1	
320	c2	**4-Aug-03**
	c2	
	c1	
	c1	
321	oic	**18-Aug-03**
	oic	
	c1	
	c1	
322	oic	**1-Sep-03**
	c1	
	c1	
	c1	
	c1	
323	c1	**15-Sep-03**
	c1	
	c1	
	c1	
401	c2	**6-Oct-03**
	c2	
	c1	
	c1	
402	c2	**20-Oct-03**
	oic	
	c1	
	c1	
	c1	
403	c2	**3-Nov-03**
	oic	
	oic	
	c1	
	c1	
404	c2	**17-Nov-03**
	c2	
	oic	
	oic	
	c1	
	c1	

FRS class # 0---	type pilot	class start date
405	c1	**1-Dec-03**
	c1	
	c1	
	c1	
406	oic	**5-Jan-04**
	oic	
	c1	
	c1	
	c1	
	c1	
407	c2	**19-Jan-04**
	oic	
	c1	
	c1	
408	oic	**2-Feb-04**
	oic	
	oic	
409	c1	**16-Feb-04**
	c1	
	c1	
	c1	
410	c1	**1-Mar-04**
	c1	
	c1	
	c1	
411	c2	**16-Mar-04**
	oic	
	c1	
	c1	
	c1	
412	c1	**5-Apr-04**
	c1	
	c1	
	c1	
413	c2	**19-Apr-04**
	oic	
	c1	
	c1	
414	oic	**3-May-04**
	c1	
	c1	
	c1	
	c1	
415	c2	**17-May-04**
	oic	
	c1	
	c1	
416	oic	**7-Jun-04**
	oic	

FRS class # 0---	type pilot	class start date
417	c2	**21-Jun-04**
	oic	
	c1	
	c1	
418	c2	**5-Jul-04**
	oic	
	c1	
	c1	
419	oic	**19-Jul-04**
	c1	
	c1	
	c1	
	c1	
420	oic	**2-Aug-04**
	c1	
	c1	
421	c1	**16-Aug-04**
	c1	
422	oic	**6-Sep-04**
	oic	
	c1	
	c1	
423	c1	**20-Sep-04**
	c1	
501	c1	**4-Oct-04**
	c1	
502	oic	**18-Oct-04**
	oic	
	c1	
	c1	
503	c1	**8-Nov-04**
	c1	
	c1	
505	oic	**6-Dec-04**
	c1	
	c1	
	c1	
506	oic	**3-Jan-05**
	c1	
	c1	
507	c1	**17-Jan-05**
	c1	
	c1	
	c1	
508	oic	**7-Feb-05**
	oic	
	oic	

FRS class # 0---	type pilot	class start date
509	c1	**21-Feb-05**
	c1	
	c1	
	c1	
	c1	
	c1	
510	c1	**7-Mar-05**
	c1	
	c1	
	c1	
511	oic	**21-Mar-05**
	c1	
	c1	
	c1	
512	c1	**4-Apr-05**
	c1	
	c1	
	c1	
513	oic	**18-Apr-05**
	c1	
	c1	
514	c1	**2-May-05**
	c1	
516	c1	**6-Jun-05**
	c1	
	c1	
	c1	
517	c1	**20-Jun-05**
	c1	
	c1	
	c1	
518	oic	**4-Jul-05**
	oic	
	c1	
	c1	
519	c1	**18-Jul-05**
	c1	
	c1	
	c1	
520	oic	**1-Aug-05**
	c1	
	c1	
	c1	
521	c1	**15-Aug-05**
	c1	
522	oic	**5-Sep-05**
	oic	
	oic	
	c1	

FRS class # 0---	type pilot	class start date
523	c1	**19-Sep-05**
	c1	
601	c1	**3-Oct-05**
	c1	
	c1	
602	oic	**17-Oct-05**
	oic	
	c1	
	c1	
603	oic	**7-Nov-05**
	c1	
	c1	
	c1	
	c1	
604	c1	**21-Nov-05**
	c1	
	c1	
	c1	

APPENDIX C. OTHCAM DISTRIBUTION OF MH-60S HELICOPTERS TO THE ACTIVE DUTY HC SQUADRONS

Fiscal Year of Production		Fiscal Year 2002												Fiscal Year 2003											
Month of Production		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Number of Aircraft Produced		2	2	2	2	1	2	2	1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	1	1
Squadrons Aircraft are Distributed To	Total Aircraft Allocated to Squadron																								
HC-5	14	2	2	2	2									1	1										
HC-6	16							2											1	1		1	1		
HC-8	16														1									1	1
HC-11	23					1	2		1	1	1	1	1			2	2	1			1				

Fiscal Year of Production		Fiscal Year 2004												Fiscal Year 2005											
Month of Production		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Number of Aircraft Produced		2	1	1	1	1	1	1	1	2	2	2	2	2	1	1	1	2	2	3	2	2	2	2	2
Squadrons Aircraft are Distributed To	Total Aircraft Allocated to Squadron																								
HC-5	14																								
HC-6	16	2								2						1			2	2	1				
HC-8	16		1	1		1	1	1	1		2	2		1	1		1								
HC-11	23				1								2	1				2		1	1	1			

Table 1. OTHCAM Distribution of MH-60S Helicopters to the HC Fleet

As this table shows, OTHCAM has a shorter planning horizon than the FIT plan because of the exclusion of non-HC squadron types. Unlike the original FIT model, OTHCAM immediately distributes all helicopters as they become available The FIT plan eventually distributes the same total number of MH-60S aircraft that each active duty HC squadron has been allocated. Once again, the four LRIP aircraft sent to HC-5 are not shown in this table, but are included in the 14 MH-60S aircraft HC-5 is allocated.

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APPENDIX D. OTHCAM DISTRIBUTION OF FRS GRADUATES TO THE ACTIVE DUTY HC SQUADRONS

FRS class # 0---	type pilot	squadron sent to
207	c2	HC5
	c2	HC5
	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC5
208	c2	HC5
	c2	HC5
	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC11
209	c2	HC11
	oic	HC11
	c1	HC5
	c1	HC11
	c1	HC11
210	c2	HC5
	c2	HC5
	oic	HC11
	c1	HC5
	c1	HC5
	c1	HC5
211	c2	HC6
	oic	HC5
	c1	HC11
	c1	HC11
	c1	HC11
212	c2	HC6
	c2	HC11
	c2	HC11
	c2	HC11
	c1	HC11
213	c2	HC11
	oic	HC11
	c1	HC5
	c1	HC5
	c1	HC11
214	c2	HC11
	c2	HC11
	oic	HC5
	c1	HC5
	c1	HC11
215	c2	HC5
	c1	HC5
	c1	HC5
	c1	HC11
	c1	HC11
	c1	HC11

FRS class # 0---	type pilot	squadron sent to
216	c2	HC11
	oic	HC11
	c1	HC11
	c1	HC11
	c1	HC11
217	c1	HC6
	c1	HC6
	c1	HC6
218	c2	HC5
	oic	HC6
	c1	HC5
	c1	HC8
219	c2	HC5
	c2	HC8
	oic	HC8
	c1	HC11
220	c2	HC5
	oic	HC5
	c1	HC8
	c1	HC11
221	c1	HC6
	c1	HC6
	c1	HC6
	c1	HC6
222	c2	HC11
	c2	HC11
	oic	HC11
	c1	HC11
	c1	HC11
223	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
301	c2	HC11
	oic	HC11
	c1	HC8
	c1	HC11
302	c2	HC11
	c2	HC11
	oic	HC11
	c1	HC11
303	oic	HC6
	c1	HC5
	c1	HC5
	c1	HC5
304	c2	HC6
	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5

FRS class # 0---	type pilot	squadron sent to
305	c1	HC5
	c1	HC5
	c1	HC6
	c1	HC11
306	c2	HC6
	c2	HC11
	oic	HC5
	oic	HC6
	c1	HC5
	c1	HC11
307	c2	HC6
	c2	HC8
	c1	HC6
	c1	HC11
308	c2	HC6
	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
309	c2	HC11
	oic	HC6
	c1	HC11
	c1	HC11
310	c2	HC6
	oic	HC6
	c1	HC5
	c1	HC6
311	c1	HC6
	c1	HC6
	c1	HC6
	c1	HC8
312	c2	HC6
	oic	HC6
	c1	HC8
	c1	HC8
313	c2	HC6
	oic	HC5
	c1	HC5
	c1	HC8
314	c2	HC8
	c2	HC8
	oic	HC8
	c1	HC8
315	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
316	c1	HC8
	c1	HC8

FRS class # 0---	type pilot	squadron sent to
317	c2	HC6
	c2	HC6
	c2	HC8
	oic	HC6
318	c1	HC5
	c1	HC6
	c1	HC6
	c1	HC6
319	oic	HC5
	oic	HC8
	c1	HC5
	c1	HC8
320	c2	HC8
	c2	HC8
	c1	HC8
	c1	HC8
321	oic	HC6
	oic	HC8
	c1	HC5
	c1	HC5
322	oic	HC6
	c1	HC5
	c1	HC5
	c1	HC11
	c1	HC11
323	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC11
401	c2	HC8
	c2	HC8
	c1	HC5
	c1	HC11
402	c2	HC8
	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC11
403	c2	HC6
	oic	HC5
	oic	HC6
	c1	HC5
	c1	HC5
404	c2	HC8
	c2	HC8
	oic	HC8
	oic	HC11
	c1	HC8
	c1	HC8

FRS class # 0---	type pilot	squadron sent to
405	c1	HC8
	c1	HC8
	c1	HC8
	c1	HC8
406	oic	HC11
	oic	HC11
	c1	HC5
	c1	HC6
	c1	HC6
	c1	HC11
407	c2	HC6
	oic	HC5
	c1	HC8
	c1	HC8
408	oic	HC5
	oic	HC8
	oic	HC8
409	c1	HC6
	c1	HC11
	c1	HC11
	c1	HC11
410	c1	HC6
	c1	HC6
	c1	HC6
	c1	HC11
411	c2	HC8
	oic	HC5
	c1	HC8
	c1	HC8
	c1	HC8
412	c1	HC6
	c1	HC11
	c1	HC11
	c1	HC11
413	c2	HC6
	oic	HC11
	c1	HC6
	c1	HC11
414	oic	HC5
	c1	HC11
	c1	HC11
	c1	HC11
	c1	HC11
415	c2	HC8
	oic	HC11
	c1	HC5
	c1	HC5
416	oic	HC8
	oic	HC8

FRS class # 0---	type pilot	squadron sent to
417	c2	HC8
	oic	HC11
	c1	HC11
	c1	HC11
418	c2	HC11
	oic	HC11
	c1	HC8
	c1	HC11
419	oic	HC8
	c1	HC6
	c1	HC6
	c1	HC11
	c1	HC11
420	oic	HC11
	c1	HC5
	c1	HC8
421	c1	HC5
	c1	HC6
422	oic	HC8
	oic	HC11
	c1	HC11
	c1	HC11
423	c1	HC8
	c1	HC11
501	c1	HC6
	c1	HC6
502	oic	HC11
	oic	HC11
	c1	HC5
	c1	HC11
503	c1	HC5
	c1	HC6
	c1	HC6
505	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC6
506	oic	HC6
	c1	HC11
	c1	HC11
507	c1	HC5
	c1	HC5
	c1	HC6
	c1	HC11
508	oic	HC5
	oic	HC6
	oic	HC6

FRS class # 0---	type pilot	squadron sent to
509	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC11
	c1	HC11
510	c1	HC5
	c1	HC6
	c1	HC6
	c1	HC8
511	oic	HC6
	c1	HC5
	c1	HC6
	c1	HC6
512	c1	HC5
	c1	HC5
	c1	HC8
	c1	HC8
513	oic	HC6
	c1	HC8
	c1	HC8
514	c1	HC5
	c1	HC5
516	c1	HC5
	c1	HC5
	c1	HC8
	c1	HC8
517	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
518	oic	HC6
	oic	HC8
	c1	HC6
	c1	HC8
519	c1	HC5
	c1	HC5
	c1	HC6
	c1	HC6
520	oic	HC6
	c1	HC5
	c1	HC8
	c1	HC8
521	c1	HC11
	c1	HC11
522	oic	HC5
	oic	HC5
	oic	HC5
	c1	HC11

FRS class # 0---	type pilot	squadron sent to
523	c1	HC5
	c1	HC5
601	c1	HC5
	c1	HC5
	c1	HC5
602	oic	HC6
	oic	HC8
	c1	HC5
	c1	HC5
603	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC8
	c1	HC8
604	c1	HC6
	c1	HC6
	c1	HC6
	c1	HC6

APPENDIX E. FIT DISTRIBUTION OF FRS GRADUATES TO THE ACTIVE DUTY HC SQUADRONS

FRS class # 0---	type pilot	squadron sent to
207	c2	HC5
	c2	HC5
	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC5
208	c2	HC5
	c2	HC6
	oic	HC6
	c1	HC6
	c1	HC6
	c1	HC6
209	c2	HC5
	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC5
210	c2	HC5
	c2	HC6
	oic	HC6
	c1	HC6
	c1	HC6
	c1	HC6
211	c2	HC6
	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC5
212	c2	HC5
	c2	HC5
	c2	HC5
	c2	HC5
	c1	HC5
213	c2	HC5
	oic	HC6
	c1	HC5
	c1	HC5
	c1	HC6
214	c2	HC6
	c2	HC6
	oic	HC5
	c1	HC6
	c1	HC6
215	c2	HC5
	c1	HC5
	c1	HC5
	c1	HC6
	c1	HC6
	c1	HC6

FRS class # 0---	type pilot	squadron sent to
216	c2	HC6
	oic	HC6
	c1	HC5
	c1	HC5
	c1	HC6
217	c1	HC5
	c1	HC5
	c1	HC6
218	c2	HC6
	oic	HC6
	c1	HC6
	c1	HC6
219	c2	HC5
	c2	HC6
	oic	HC5
	c1	HC5
220	c2	HC5
	oic	HC5
	c1	HC5
	c1	HC5
221	c1	HC5
	c1	HC8
	c1	HC8
	c1	HC8
222	c2	HC8
	c2	HC8
	oic	HC8
	c1	HC5
	c1	HC5
223	c1	HC8
	c1	HC11
	c1	HC11
	c1	HC11
301	c2	HC8
	oic	HC8
	c1	HC6
	c1	HC8
302	c2	HC11
	c2	HC11
	oic	HC11
	c1	HC5
303	oic	HC11
	c1	HC11
	c1	HC11
	c1	HC11
304	c2	HC11
	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC6

FRS class # 0---	type pilot	squadron sent to
305	c1	HC5
	c1	HC6
	c1	HC6
	c1	HC6
306	c2	HC5
	c2	HC6
	oic	HC5
	oic	HC6
	c1	HC5
	c1	HC5
307	c2	HC8
	c2	HC11
	c1	HC6
	c1	HC8
308	c2	HC5
	oic	HC6
	c1	HC6
	c1	HC6
	c1	HC6
	c1	HC6
309	c2	HC8
	oic	HC8
	c1	HC5
	c1	HC8
310	c2	HC11
	oic	HC11
	c1	HC11
	c1	HC11
311	c1	HC8
	c1	HC8
	c1	HC11
	c1	HC11
312	c2	HC11
	oic	HC8
	c1	HC6
	c1	HC6
313	c2	HC11
	oic	HC11
	c1	HC11
	c1	HC11
314	c2	HC8
	c2	HC11
	oic	HC8
	c1	HC8
315	c1	HC11
	c1	HC11
	c1	HC11
	c1	HC11
316	c1	HC8
	c1	HC8

FRS class # 0---	type pilot	squadron sent to
317	c2	HC8
	c2	HC11
	c2	HC11
	oic	HC11
318	c1	HC8
	c1	HC8
	c1	HC8
	c1	HC8
319	oic	HC5
	oic	HC8
	c1	HC5
	c1	HC5
320	c2	HC8
	c2	HC8
	c1	HC6
	c1	HC8
321	oic	HC5
	oic	HC5
	c1	HC5
	c1	HC5
322	oic	HC8
	c1	HC6
	c1	HC8
	c1	HC8
	c1	HC8
323	c1	HC11
	c1	HC11
	c1	HC11
	c1	HC11
401	c2	HC8
	c2	HC8
	c1	HC8
	c1	HC8
402	c2	HC11
	oic	HC8
	c1	HC8
	c1	HC8
	c1	HC8
403	c2	HC11
	oic	HC6
	oic	HC11
	c1	HC11
	c1	HC11
404	c2	HC11
	c2	HC11
	oic	HC11
	oic	HC11
	c1	HC11
	c1	HC11

FRS class # 0---	type pilot	squadron sent to
405	c1	HC5
	c1	HC5
	c1	HC6
	c1	HC6
406	oic	HC5
	oic	HC6
	c1	HC5
	c1	HC5
	c1	HC6
	c1	HC8
407	c2	HC11
	oic	HC11
	c1	HC11
	c1	HC11
408	oic	HC5
	oic	HC6
	oic	HC8
409	c1	HC5
	c1	HC6
	c1	HC8
	c1	HC8
410	c1	HC5
	c1	HC5
	c1	HC8
	c1	HC8
411	c2	HC8
	oic	HC5
	c1	HC5
	c1	HC6
	c1	HC6
412	c1	HC11
	c1	HC11
	c1	HC11
	c1	HC11
413	c2	HC11
	oic	HC5
	c1	HC5
	c1	HC11
414	oic	HC11
	c1	HC6
	c1	HC11
	c1	HC11
	c1	HC11
415	c2	HC11
	oic	HC11
	c1	HC11
	c1	HC11
416	oic	HC6
	oic	HC6

FRS class # 0---	type pilot	squadron sent to
417	c2	HC11
	oic	HC6
	c1	HC5
	c1	HC5
418	c2	HC11
	oic	HC11
	c1	HC11
	c1	HC11
419	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
420	oic	HC5
	c1	HC8
	c1	HC8
421	c1	HC5
	c1	HC5
422	oic	HC8
	oic	HC8
	c1	HC8
	c1	HC11
423	c1	HC11
	c1	HC11
501	c1	HC11
	c1	HC11
502	oic	HC11
	oic	HC11
	c1	HC5
	c1	HC11
503	c1	HC6
	c1	HC8
	c1	HC11
505	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC5
506	oic	HC6
	c1	HC8
	c1	HC11
507	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC11
508	oic	HC6
	oic	HC8
	oic	HC11

FRS class # 0---	type pilot	squadron sent to
509	c1	HC5
	c1	HC5
	c1	HC6
	c1	HC6
	c1	HC6
	c1	HC11
510	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
511	oic	HC8
	c1	HC8
	c1	HC11
	c1	HC11
512	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC11
513	oic	HC8
	c1	HC5
	c1	HC8
514	c1	HC11
	c1	HC11
516	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC6
517	c1	HC6
	c1	HC6
	c1	HC8
	c1	HC8
518	oic	HC8
	oic	HC11
	c1	HC5
	c1	HC5
519	c1	HC5
	c1	HC6
	c1	HC6
	c1	HC6
520	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC5
521	c1	HC8
	c1	HC8
522	oic	HC5
	oic	HC6
	oic	HC8
	c1	HC6

FRS class # 0---	type pilot	squadron sent to
523	c1	HC11
	c1	HC11
601	c1	HC5
	c1	HC6
	c1	HC6
602	oic	HC8
	oic	HC11
	c1	HC11
	c1	HC11
603	oic	HC11
	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC11
604	c1	HC6
	c1	HC6
	c1	HC6
	c1	HC6

APPENDIX F. OTHCAM DISTRIBUTION OF MH-60S HELICOPTERS TO THE ACTIVE DUTY HC SQUADRONS WHEN ADJUSTED FOR ADDITIONAL FIT CONSTRAINTS

Fiscal Year of Production		Fiscal Year 2002												Fiscal Year 2003											
Month of Production		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Number of Aircraft Produced		2	2	2	2	1	2	2	1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	1	1
Squadrons Aircraft are Distributed To	Total Aircraft Allocated to Squadron																								
HC-5	14	2	2	2		1			1	1			1												
HC-6	16				2		2	2			1	1		1	1										
HC-8	16														1	1	1			1	1		1		1
HC-11	23															1	1	1	1			1		1	

Fiscal Year of Production		Fiscal Year 2004												Fiscal Year 2005											
Month of Production		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Number of Aircraft Produced		2	1	1	1	1	1	1	1	2	2	2	2	2	1	1	1	2	2	3	2	2	2	2	2
Squadrons Aircraft are Distributed To	Total Aircraft Allocated to Squadron																								
HC-5	14																								
HC-6	16													2				1		3					
HC-8	16		1						1	1	2				1	1	1	1							
HC-11	23	2		1	1	1	1	1		1		2	2						2		2	1			

Table 1. OTHCAM Distribution of MH-60S Helicopters to the HC Fleet When Adjusted for the Additional FIT Constraints

Once again, the four LRIP aircraft sent to HC-5 are not shown in this table, but are included in the 14 MH-60S aircraft HC-5 is allocated. The dashed line after June 2004 indicates the mandatory retirement date of the H-46. The distribution of MH-60S aircraft before this date is identical to the FIT plan in order to meet the operational and contractual constraints the FIT has declared indispensable. OTHCAM distributes the remaining 21 aircraft in the most efficient way possible in order to reduce the number of lost fly days.

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APPENDIX G. OTHCAM DISTRIBUTION OF FRS GRADUATES WHEN ADJUSTED FOR ADDITIONAL FIT CONSTRAINTS

FRS class # 0---	type pilot	squadron sent to
207	c2	HC5
	c2	HC5
	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC5
208	c2	HC5
	c2	HC5
	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC6
209	c2	HC6
	oic	HC6
	c1	HC6
	c1	HC6
	c1	HC6
210	c2	HC6
	c2	HC6
	oic	HC6
	c1	HC5
	c1	HC6
	c1	HC6
211	c2	HC6
	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC5
212	c2	HC5
	c2	HC5
	c2	HC5
	c2	HC5
	c1	HC5
213	c2	HC5
	oic	HC6
	c1	HC5
	c1	HC6
	c1	HC6
214	c2	HC6
	c2	HC6
	oic	HC6
	c1	HC6
	c1	HC6
215	c2	HC6
	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC6
	c1	HC6

FRS class # 0---	type pilot	squadron sent to
216	c2	HC6
	oic	HC5
	c1	HC5
	c1	HC6
	c1	HC6
217	c1	HC6
	c1	HC8
	c1	HC8
218	c2	HC8
	oic	HC8
	c1	HC5
	c1	HC8
219	c2	HC6
	c2	HC6
	oic	HC6
	c1	HC8
220	c2	HC8
	oic	HC8
	c1	HC8
	c1	HC8
221	c1	HC5
	c1	HC5
	c1	HC8
	c1	HC8
222	c2	HC6
	c2	HC8
	oic	HC8
	c1	HC5
	c1	HC6
223	c1	HC6
	c1	HC11
	c1	HC11
	c1	HC11
301	c2	HC11
	oic	HC11
	c1	HC11
	c1	HC11
302	c2	HC11
	c2	HC11
	oic	HC11
	c1	HC5
303	oic	HC5
	c1	HC5
	c1	HC5
	c1	HC5
304	c2	HC5
	c1	HC5
	c1	HC8
	c1	HC11
	c1	HC11

FRS class # 0---	type pilot	squadron sent to
305	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
306	c2	HC8
	c2	HC8
	oic	HC5
	oic	HC11
	c1	HC8
	c1	HC11
307	c2	HC8
	c2	HC11
	c1	HC8
	c1	HC11
308	c2	HC11
	oic	HC11
	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
309	c2	HC8
	oic	HC11
	c1	HC11
	c1	HC11
310	c2	HC11
	oic	HC5
	c1	HC5
	c1	HC11
311	c1	HC8
	c1	HC11
	c1	HC11
	c1	HC11
312	c2	HC11
	oic	HC6
	c1	HC8
	c1	HC8
313	c2	HC8
	oic	HC8
	c1	HC5
	c1	HC11
314	c2	HC11
	c2	HC11
	oic	HC6
	c1	HC8
315	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
316	c1	HC11
	c1	HC11

FRS class # 0---	type pilot	squadron sent to
317	c2	HC8
	c2	HC11
	c2	HC11
	oic	HC6
318	c1	HC5
	c1	HC5
	c1	HC11
	c1	HC11
319	oic	HC5
	oic	HC6
	c1	HC8
	c1	HC11
320	c2	HC11
	c2	HC11
	c1	HC6
	c1	HC6
321	oic	HC6
	oic	HC8
	c1	HC5
	c1	HC5
322	oic	HC8
	c1	HC5
	c1	HC5
	c1	HC6
	c1	HC6
323	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
401	c2	HC8
	c2	HC8
	c1	HC5
	c1	HC5
402	c2	HC11
	oic	HC8
	c1	HC5
	c1	HC6
	c1	HC6
403	c2	HC8
	oic	HC8
	oic	HC11
	c1	HC11
	c1	HC11
404	c2	HC11
	c2	HC11
	oic	HC11
	oic	HC11
	c1	HC5
	c1	HC6

FRS class # 0---	type pilot	squadron sent to
405	c1	HC8
	c1	HC8
	c1	HC8
	c1	HC8
406	oic	HC11
	oic	HC11
	c1	HC8
	c1	HC8
	c1	HC8
	c1	HC8
407	c2	HC6
	oic	HC5
	c1	HC5
	c1	HC5
408	oic	HC5
	oic	HC5
	oic	HC5
409	c1	HC6
	c1	HC11
	c1	HC11
	c1	HC11
410	c1	HC6
	c1	HC11
	c1	HC11
	c1	HC11
411	c2	HC6
	oic	HC6
	c1	HC11
	c1	HC11
	c1	HC11
412	c1	HC6
	c1	HC6
	c1	HC6
	c1	HC6
413	c2	HC11
	oic	HC6
	c1	HC6
	c1	HC6
414	oic	HC11
	c1	HC6
	c1	HC6
	c1	HC6
	c1	HC6
415	c2	HC11
	oic	HC5
	c1	HC5
	c1	HC5
416	oic	HC5
	oic	HC5

FRS class # 0---	type pilot	squadron sent to
417	c2	HC6
	oic	HC6
	c1	HC8
	c1	HC8
418	c2	HC6
	oic	HC8
	c1	HC6
	c1	HC8
419	oic	HC8
	c1	HC5
	c1	HC8
	c1	HC8
	c1	HC8
420	oic	HC8
	c1	HC6
	c1	HC6
421	c1	HC8
	c1	HC8
422	oic	HC8
	oic	HC8
	c1	HC6
	c1	HC6
423	c1	HC5
	c1	HC5
501	c1	HC11
	c1	HC11
502	oic	HC11
	oic	HC11
	c1	HC11
	c1	HC11
503	c1	HC8
	c1	HC11
	c1	HC11
505	oic	HC6
	c1	HC5
	c1	HC5
	c1	HC11
506	oic	HC11
	c1	HC8
	c1	HC11
507	c1	HC5
	c1	HC5
	c1	HC8
	c1	HC11
508	oic	HC5
	oic	HC6
	oic	HC11

FRS class # 0---	type pilot	squadron sent to
509	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
510	c1	HC11
	c1	HC11
	c1	HC11
	c1	HC11
511	oic	HC6
	c1	HC5
	c1	HC5
	c1	HC8
512	c1	HC5
	c1	HC8
	c1	HC8
	c1	HC11
513	oic	HC8
	c1	HC5
	c1	HC8
514	c1	HC11
	c1	HC11
516	c1	HC5
	c1	HC5
	c1	HC11
	c1	HC11
517	c1	HC5
	c1	HC5
	c1	HC5
	c1	HC5
518	oic	HC6
	oic	HC6
	c1	HC8
	c1	HC11
519	c1	HC5
	c1	HC5
	c1	HC11
	c1	HC11
520	oic	HC11
	c1	HC5
	c1	HC6
	c1	HC6
521	c1	HC6
	c1	HC6
522	oic	HC5
	oic	HC8
	oic	HC8
	c1	HC5

FRS class # 0---	type pilot	squadron sent to
523	c1	HC5
	c1	HC5
601	c1	HC5
	c1	HC5
	c1	HC5
602	oic	HC5
	oic	HC11
	c1	HC5
	c1	HC5
603	oic	HC11
	c1	HC6
	c1	HC6
	c1	HC6
	c1	HC11
604	c1	HC11
	c1	HC11
	c1	HC11
	c1	HC11

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