Analysis of Plane-Side Maintenance Factors

Burton L. Streicher • Rebecca L. Kirk • Daniel N. Carvell
with Stephen C. Goodwyn, Kletus S. Lawler, and Christopher J. Petrillo

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Photo credit line: 121210-N-NB538-096 - ATLANTIC OCEAN (Dec. 10, 2012). Aviation Electronics Technician 2nd Class Jonathan Shafer and Aviation Electronics Technician 3rd Class Nathan Bott, both assigned to the Rampagers of Strike Fighter Squadron (VFA) 83, run diagnostics on the electronic components of an F/A-18C Hornet aboard the aircraft carrier *USS Dwight D. Eisenhower* (CVN 69). *Dwight D. Eisenhower* was returning to Norfolk after operating in the U.S. 5th and 6th Fleet areas of responsibility in support of Operation Enduring Freedom, maritime security operations and theater security cooperation efforts. (U.S. Navy photo by Mass Communication Specialist 3rd Class Sabrina Fine/Released)

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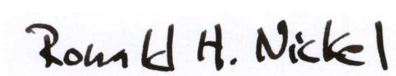

Ronald H. Nickel, Director
Cost Acquisition, Readiness, and Logistics Team
Resource Analysis Division

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Executive summary

The Director, Air Warfare Division (OPNAV N98), asked CNA to examine the aircraft maintenance factors at the plane-side organizational level (O-level) that affect aircraft readiness and the total cost of O-level aircraft maintenance. The Navy is concerned that changing levels of experience of aviation maintenance personnel, along with changing outside technical assistance support such as that provided by the Naval Air Technical Data and Engineering Service Command (NATEC), may be negatively affecting aircraft readiness.

Approach

CNA conducted an empirical analysis of aviation O-level operational data by collecting Navy squadron historical information from fiscal years (FY) 2004 through 2012 on 145 squadrons, which we segmented into 13 broadly defined squadron mission types. We developed a readiness figure of merit, which we call the *maintenance support rate* (MSR). The MSR is the squadron total number of aircraft available in hours less the hours aircraft are unavailable for maintenance reasons divided by the total availability. It is a measure that represents the percentage of scheduled time that the squadron's aircraft are available to operate. This kind of measure is commonly known as an *equipment uptime rate.*

We created a master data table of information that included the fiscal year, individual squadron characteristics, plane-side maintenance factor variables, and maintenance outcome measures. Our analysis was conducted in two phases. First, we conducted individual data factor analyses by type of aviation squadron in order to identify trends and variation in the O-level maintenance factors themselves. Once we determined the degree of change in each variable, we conducted fixed-effect data regression analyses to identify the relationship and degree of variation influence of each of the maintenance factors on the actual aircraft O-level maintenance costs and readiness measures.

Using the information obtained in these analyses, we then examined potential future courses of action to best maintain fleet aviation readiness and control maintenance costs in light of possible future budget reductions.

Findings

The readiness MSR for most squadrons has declined over the nine fiscal years studied, resulting in an overall 5.8-percentage point drop to a 60.6 percent rate. We also found that the average O-level maintenance cost per equipment in service (EIS) hour decreased by 8.7 percent, or $20 per hour in constant FY 2012 dollars.

The following maintenance factors experienced the greatest change:

- Contract maintenance costs in constant dollars allocated to squadrons grew by 57.6 percent.
- Total annual partially mission capable due to maintenance (PMCM) hours grew by 21.7 percent.
- Total not mission capable due to maintenance (NMCM) hours grew by 20.6 percent.
- The average logged maintenance hours per maintainer dropped by 14.0 percent.
- The number of enlisted maintenance personnel in the squadrons dropped by 27.0 percent.
- The number of enlisted E6 maintenance personnel in the squadrons dropped by 30.8 percent.
- The number of enlisted E5 maintenance personnel in the squadrons dropped by 31.1 percent.
- The number of enlisted E1 to E3 maintenance personnel in the squadrons dropped by 42.1 percent.
- The total annual logged maintenance hours dropped by 46.4 percent.

The following O-level maintenance factors have the greatest influence on squadron MSR:

- Number of maintainers in a squadron
- Squadron manpower FILL rate
- Average maintainer time in unit
- Number of logged maintenance man-hours
- Average maintainer career time in squadrons
- Average age of aircraft being maintained
- Number of aircraft being maintained

Based on these findings, we can determine that the two initial focus areas—(1) squadron maintainer experience levels and (2) quantity of outside technical maintenance support provided by NATEC—are not the current drivers of the MSR readiness decline. In fact, average levels of experience in the current unit, career time in squadrons, and career time with aircraft type/model/series (T/M/S) have actually increased over the nine years studied.

The findings suggest that the decline in MSR is driven mostly by the reduction in logged maintenance man-hours resulting from fewer enlisted maintainers assigned to squadrons and a reduced number of hours per maintainer for those still assigned there.

Recommendations

Based on our findings, and as a course of action to control costs and stabilize the squadron MSRs, we recommend the following actions be investigated:

- Consider increasing tour lengths for maintainer assignments, based on that factor's positive effect on MSR, working closely with OPNAV N1 to assess potential personnel-related impacts.
- Closely investigate the drop in logged maintenance hours per maintainer to determine what is causing this loss of maintenance productivity.
- Perform a cost-benefit analysis with respect to restoring the number of enlisted maintainers in the squadrons to levels closer to pre–FY 2007 numbers.

- Revisit the decision to remove nonrated enlisted from the squadrons, as this action may have diverted Petty Officers from aircraft maintenance duties to deal with tasks previously accomplished by the junior enlisted.
- Coordinate a central repository of all fleet aviation unit fleet response plan (FRP) cycle histories, as this information is currently available only for carrier-based squadrons.
- Improve and better publicize access to NATEC support.
- More formally integrate NATEC squadron technical maintenance training into the predeployment workup phase of the squadron FRP cycle in order to better prepare squadrons for deployment.
- Establish a centralized Navy database of all contract technical maintenance support, especially as it relates to the O-level units, to better avoid wasted in-house support efforts.
- Generate separate financial program elements for Navy and Marine Corps engineering technical support requirements.
- Perform additional technical support analysis at the work unit code (WUC) or system level in order to better observe the benefits of outside technical assistance to the overall squadron aircraft MSRs.
- Develop a price performance model to enable future forecasting of outside technical support–level impact on fleet requests for support and aircraft MSRs as a result of adjustments to NATEC resourcing levels.

We believe that implementing some or all of these recommendations will help control O-level maintenance costs and improve the MSRs. However, the primary focus should be on getting more enlisted maintainers back into the squadrons for longer tour lengths in order to generate more logged maintenance hours.

Introduction

The Navy is concerned that it may be faced with the prospect of higher aviation maintenance costs and lower readiness levels because of the combination of reduced technical experience in the aviation organizational level (O-level) maintenance workforce and reduced outside technical assistance, currently provided by the Naval Air Technical Data and Engineering Service Command (NATEC). Given this concern, the Navy would like to better understand the effect of these maintenance workforce changes on overall cost and readiness measures.

Background

It is suspected that recent adjustments to aviation maintenance practices, personnel availability, and enlisted military retention have changed the technical experience levels of the O-level maintenance workforce. CNA was asked by the Director, Air Warfare Division (OPNAV N98), to examine the aircraft maintenance factors at the plane-side O-level that affect aircraft maintenance readiness and the total cost of O-level aircraft maintenance.

The two main areas of interest are the effects of (1) changing experience levels in the aviation maintenance workforce and (2) changing levels of outside technical assistance that is provided by NATEC.

Issues

The potential for future budget reductions and ongoing new aircraft introductions to the fleet inventory along with adjustments in squadron manpower allowances have generated a period of uncertainty and change for the aviation maintenance community. The Navy aviation resource sponsor is concerned that the possibility of reduced technical experience within the O-level workforce and reduced outside technical assistance could together lead to increasing aircraft maintenance costs and reduced fleet readiness status. OPNAV N98 would like to know what potential effects these changes in plane-side maintenance factors have on the overall aircraft maintenance costs and fleet readiness measures.

The goal is to adjust resources for the most significant drivers in order to control cost growth and maintain readiness levels during this period of fiscal uncertainty and change.

Study approach

CNA conducted an empirical analysis of aviation operational data by collecting Navy squadron historical information from fiscal years (FY) 2004 through 2012, which included operational maintenance data, maintenance personnel manning and experience level information, aircraft maintenance readiness measures, and annual certified obligations. We developed a readiness figure of merit, which we called the *maintenance support rate* (MSR), which is the total squadron aircraft availability in hours less the hours aircraft are unavailable for maintenance reasons divided by the total availability. It is in essence a measure that represents the percentage of scheduled time that the squadron's aircraft are available to operate. This kind of measure is often referred to as an *equipment uptime rate*.

For this kind of analysis, MSR is a better metric than the currently used aviation readiness measure *ready for tasking* (RFT). That metric introduces a filter that allows for partial aircraft availability and considers only the aircraft necessary to meet current mission requirements. This can mask the true measure of total aircraft availability.

The Naval Aviation Enterprise established new goals for aviation readiness in 2006[1]. RFT and *ready basic aircraft* (RBA) became the new standard that squadrons worked toward in meeting mission requirements. The sponsor asked us to use RFT as the readiness standard

1. Type/Model/Series (T/M/S) Readiness and Resource Standards for Naval Air Force Units. COMNAVAIRPACINTST/COMNAVAIRLANTINST 3510.11C. December 13, 2012.

when analyzing the squadron manpower, readiness, and costs. Because RFT did not have a common reporting standardization until 2008 there is no consistent historical dataset. Additionally we were unable to create a coherent dataset from combining recent RFT reports with historical material condition reporting. We examined two years of F/A-18 RFT data for one squadron. After reviewing the data and several discussions with the sponsor, we chose to use the total hours squadron aircraft reported degradation for maintenance as a more appropriate metric for this study.

Although the RFT readiness measure was not available with enough history to use in factor or data regression analysis, we were able to use the DECKPLATE (decision knowledge programming for logistics analysis and technical evaluation) database to extract the readiness feeder measurements we needed to calculate our MSR metrics.

We built a master data table of information, which includes the fiscal year, individual aviation squadron characteristics, maintenance factor variables, and maintenance outcome measures. We conducted individual data factor analyses by type of aviation squadron to identify trends and variation in the O-level maintenance factors themselves. Finally, we conducted data regression analyses to determine what relationships exist and the degree of variation influence of the maintenance factors on the actual aircraft maintenance costs and readiness measures.

Once these relationships were identified, we examined the potential courses of action that could be taken in order to best maintain fleet aviation readiness and control costs in light of possible future budget reductions.

Price performance model question

To address the second of the two main research questions for this study meant looking at the technical assistance provided by NATEC. Given the data to be examined, OPNAV N43 and OPNAV N98 asked CNA, while conducting this study, to determine whether there is enough data to create a performance pricing model for the account that funds NATEC. That analysis was performed and our findings are described in Appendix B.

Factors selected for analysis

We used existing Navy databases to extract and consolidate the relevant information into our master data analysis table. Since we examine the relationship of maintenance manpower experience levels at the squadron O-level, our data grouping was for individual aviation squadrons and our analysis time period was by fiscal year since financial records are adjusted at the end of each fiscal year to accurately reflect the true certified obligations for the financial accounts and billable activities. We further segmented the annual squadron information by the T/M/S assigned to them that year.

Squadrons included in analysis

We focused only on Navy (USMC squadrons were not included) and fleet support squadrons which do not include the training squadrons or special purpose and research and development squadrons, such as the Blue Angels. We also did not include station aircraft in the analysis. We collected information on 145 squadrons which we segmented into 13 broadly defined squadron mission types. Table 1 shows these groupings.

Table 1. Navy aviation squadron mission types

Aviation class	Aviation type	Aviation designators
Fixed	Early warning	VAW
Fixed	Electronic attack	VAQ
Fixed	Fighter composite	VFC
Fixed	Logistic support	VR, VRC
Fixed	Patrol	VP
Fixed	Reconnaissance	VQ
Fixed	Special project	VPU
Fixed	Strike fighter	VF, VFA

Table 1. Navy aviation squadron mission types

Aviation class	Aviation type	Aviation designators
Rotary	Antisubmarine	HS
Rotary	Antisubmarine light	HSL
Rotary	Maritime strike	HSM
Rotary	Mine countermeasures	HM
Rotary	Sea combat	HSC

Master data table structure

We selected an aviation squadron at random to use as a pilot to determine what information was available and how to set up the table structure. We selected N09560 VFA-11 Red Rippers homeported at NAS Oceana, Virginia. We grouped our master data table into four major category types of information:

- Time interval
- Squadron characteristics
- Maintenance factor variables
- Maintenance outcome measures

Table 2 provides a summary of the data fields used along with descriptions and information data type.

Table 2. Master data table field structure and descriptions

Variable type	Field name	Data type	Field description	Example
Time interval	FY	Text	Fiscal year	2012
Squadron characteristics	Aviation UIC	Alphanumeric	Squadron unique unit identification code (UIC)	N09560
	Aviation Unit Name	Text	Name of aviation unit	VFA 11
	Squadron Class	Text	Squadron aviation class	Fixed
	Squadron Type	Text	Squadron mission designation type	Strike Fighter
	Squadron Nickname	Text	Squadron selected nickname	Red Rippers
	Homeport UIC	Alphanumeric	Assigned homeport unique unit identification code	N60191

Table 2. Master data table field structure and descriptions

Variable type	Field name	Data type	Field description	Example
	Homeport Name	Text	Name of homeport installation	NAS OCEANA VA
	Number of Aircraft	Number	Number of T/M/S aircraft assigned to squadron during fiscal year	10
	Aircraft T/M/S	Alphanumeric	Assigned T/M/S of aircraft	F/A-18F
	Average Age of Aircraft	Number	Average age in months of squadron assigned aircraft at end of the fiscal year	120
	Total Aircraft Flying Hours	Hours	Total squadron flying hours logged during fiscal year	4,000.0
	FRP Deploy %	Percentage	Percentage of year squadron was deployed during fiscal year	54.9%
Maintenance factor variables	Number of Maintainers	Number	EOFY total unit maintenance personnel on-board E3 through E6	224
	Maint Pers FILL Rate	Percentage	Ratio of total unit maintenance personnel on-board divided by total maintenance billets authorized during fiscal year	98.6%
	Maint Pers FIT Rate	Percentage	Ratio of total unit maintenance personnel with NEC to total NEC requirements of squadron during fiscal year	92.2%
	Maint Pers Unit Man-Months Exp	Number	EOFY maintenance personnel total of man-months served in current unit	4,100
	Maint Pers Squadron Man-Months Exp	Number	EOFY maintenance personnel total career man-months served in squadrons	7,969
	Maint Pers T/M/S Man-Months Exp	Number	EOFY maintenance personnel total career man-months with squadron T/M/S aircraft	22,425
	NATEC RFA Hours	Hours	Annual squadron total hours of NATEC request for assistance (RFA) support provided	17.0
	NATEC RFI Hours	Hours	Annual squadron total hours of NATEC request for information (RFI) support provided	11.0

Table 2. Master data table field structure and descriptions

Variable type	Field name	Data type	Field description	Example
	NATEC RFT Hours	Hours	Annual squadron total hours of NATEC request for training (RFT) support provided	144.0
Maintenance outcome measures	Annual AFM Cost (FM)[a]	Currency	Annual spend to purchase aviation fleet maintenance (AFM) items such as consumable repair parts (gaskets, tires, wire, etc.), tools, greases, safety and flight deck shoes, etc.	$3,651,342
	Annual AVDLR Cost (FA)[b]	Currency	Annual spend to purchase high-cost depot repairable parts	$9,816,946
	Annual Contract Maint Cost (FW)[c]	Currency	Annual spend to purchase aviation fleet maintenance contract support	$325,088
	Annual Logged Maintenance Man-hours	Number	Annual squadron total logged maintenance man-hours by T/M/S	181,198.9
	Annual NMCM Hours	Hours	Annual squadron total not mission capable due to maintenance (NMCM) hours	30,832.0
	Annual PMCM Hours	Hours	Annual squadron total partially mission capable due to maintenance (PMCM) hours	11,002.0
	Annual Primary NMCM Hours	Hours	Annual squadron total primary not mission capable just due to maintenance (NMCM) hours	22,937.3
	Annual Primary PMCM Hours	Hours	Annual squadron total primary partially mission capable just due to maintenance (PMCM) hours	8,729.6
	Annual EIS Hours	Hours	Annual squadron total Equipment In Service (EIS) hours	97,338.0
	Maint Support Rate	Percentage	Ratio of annual EIS hours minus sum of primary NMCM hours and primary PMCM hours divided by annual EIS hours	67.5

a. FM is the two digit cost code that captures aviation fleet maintenance item expenditures
b. FA is the two digit cost code that captures aviation depot level repairable part expenditures
c. FW is the two digit cost code that captures purchased aviation fleet maintenance contract expenditures

From this master data table, we extracted information to conduct individual data factor analyses by type of aviation squadron in order to identify trends and variation in the O-level maintenance factors themselves.

We populated the master data table with information contained in five different existing Navy data management systems. We used the engineering technical services (ETS) local assist request version 2 (ELAR II) system [1] to obtain the NATEC support hours and related information. The aviation maintenance information was extracted from the Navy's decision knowledge programming for logistics analysis and technical evaluation (DECKPLATE) data system [2]. The aircraft inventory assignment, flight hours, and age information was obtained from the aircraft inventory and readiness reporting system (AIRRS) database [3]. The squadron manpower inventory, billets authorized, and career experience information comes from the Navy's total force manpower management system (TFMMS) database [4]. The squadron unit identification codes (UICs) and homeports were found in the standard naval distribution list (SNDL) [5]. For financial information on squadron costing, we used the FY 2012 OP-20 Navy operations and maintenance budget exhibit [6].

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Individual data factor analyses

We organized the data by fiscal year and type of aircraft squadron. We also included a totals column. We calculated the percentage of change from FY 2004 to FY 2012 and the actual magnitude of the change. We identified the minimum, maximum, and mean annual total over the nine years. We also identified the standard deviation (SD) and coefficient of variability (CV) over the same period.

Squadron characteristics

As table 2 shows, 12 fields capture the nature and missions of the aviation squadrons. We looked at 4 of the fields to determine the extent of operational change over the nine years. The other fields are used to identify the specific squadron and its homeport.

We also attempted to capture how much of a given fiscal year a squadron was deployed or in the deep maintenance portion of its fleet response plan (FRP) cycle. We were able to find only the deployment times of aircraft carrier tactical air squadrons, therefore, we did not use this partial information in our analysis. We were not able to identify any source that would give us the annual squadron deep maintenance percentage times. Therefore, we dropped that maintenance cycle factor from our master data table.

Squadron types

Figure 1 shows the number and type of squadrons in our analysis pool.

Note that strike fighter squadrons make up almost a third of all squadrons so they tend to have more influence on the overall inventory analysis. Table 3 provides a summary of the total column from figure 1.

Figure 1. Number of Navy aviation squadrons by type, FY 2004 to FY 2012

Number of squadrons														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	39	15	15	17	11	3	2	2	14	8	5	5	2	138
2005	39	15	15	17	11	3	2	2	14	8	5	5	2	138
2006	39	15	15	17	11	3	2	2	15	8	6	5	2	140
2007	39	15	15	17	11	3	3	2	16	8	6	5	2	142
2008	39	15	15	17	11	3	3	2	16	8	6	5	2	142
2009	39	15	15	17	11	3	3	2	16	8	7	5	2	143
2010	39	15	15	17	11	3	3	2	16	8	7	5	2	143
2011	38	15	15	17	11	3	3	2	16	8	7	5	2	142
2012	38	15	15	17	11	3	3	2	16	8	8	5	2	143
Change	**-2.6%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**50.0%**	**0.0%**	**14.3%**	**0.0%**	**60.0%**	**0.0%**	**0.0%**	**3.6%**
	-1	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**2**	**0**	**3**	**0**	**0**	**5**

Table 3. Navy aviation squadron, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
143	141	138	3.6%	5	2	0.01

The total number of squadrons has remained relatively steady. Figure 2 shows the distribution between fixed-wing and rotary squadrons.

While examining the source information in our master data table it became clear that there are significant operational differences between the overall results of the fixed-wing and rotary aviation communities mostly as a result of the different natures of the aircraft they operate. Therefore we decided to break out the overall results for each of our analysis measures to highlight the differences.

Number of aircraft T/M/S maintained

Figure 3 shows the number of aircraft maintained in the squadrons.

Table 4 provides a summary of the total column in figure 3.

The total number of aircraft has grown, increasing 2.9 percent or 40 aircraft between FY 2004 and FY 2012. There were no large variations in total numbers during the period. Figures 4 and 5 provide the breakout between fixed-wing and rotary squadrons.

Figure 2. Navy aviation squadrons type distribution, FY 2004 to FY 2012

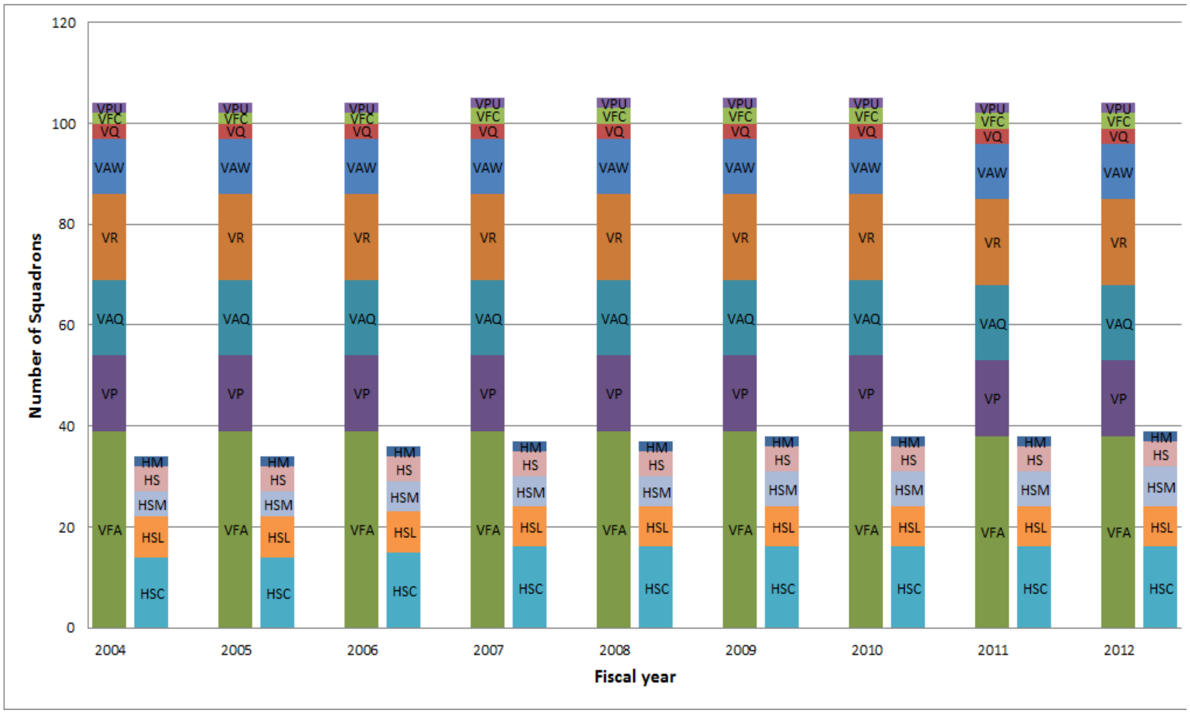


Figure 3. Number of Navy aircraft T/M/S maintained by squadrons, FY 2004 to FY 2012

Number of aircraft maintained														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	577	139	88	83	44	23	34	10	137	90	57	42	26	1,351
2005	561	117	90	76	48	24	34	9	132	90	56	40	24	1,301
2006	559	129	84	74	45	24	38	8	119	92	56	41	22	1,292
2007	588	117	81	74	42	25	38	8	123	90	58	47	26	1,319
2008	627	79	78	66	28	19	42	8	126	87	62	45	28	1,295
2009	641	100	80	67	38	17	44	7	100	97	71	44	22	1,328
2010	657	128	82	69	47	24	43	8	151	97	85	46	25	1,462
2011	564	113	93	71	48	24	44	8	181	80	79	45	25	1,377
2012	556	84	102	71	47	30	44	8	196	80	109	37	24	1,391
Change	-3.6%	-39.2%	16.9%	-14.0%	6.3%	33.0%	28.4%	-20.5%	42.9%	-11.2%	90.6%	-11.5%	-7.7%	2.9%
	-21	-54	15	-12	3	8	10	-2	59	-10	52	-5	-2	40

Table 4. Navy T/M/S aircraft maintained, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
1,462	1,346	1,292	2.9%	40	56	0.04

Figure 4. Number of fixed-wing aircraft maintained

Number of fixed-wing aircraft maintained									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	44	88	34	83	139	23	10	577	998
2005	48	90	34	76	117	24	9	561	959
2006	45	84	38	74	129	24	8	559	961
2007	42	81	38	74	117	25	8	588	974
2008	28	78	42	66	79	19	8	627	947
2009	38	80	44	67	100	17	7	641	994
2010	47	82	43	69	128	24	8	657	1,059
2011	48	93	44	71	113	24	8	564	966
2012	47	102	44	71	84	30	8	556	944
Change	6.3%	16.9%	28.4%	-14.0%	-39.2%	33.0%	-20.5%	-3.6%	-5.4%
	3	15	10	-12	-54	8	-2	-21	-54

Figure 5. Number of rotary aircraft maintained

Number of rotary aircraft maintained						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	42	90	57	26	137	353
2005	40	90	56	24	132	342
2006	41	92	56	22	119	330
2007	47	90	58	26	123	345
2008	45	87	62	28	126	348
2009	44	97	71	22	100	334
2010	46	97	85	25	151	403
2011	45	80	79	25	181	411
2012	37	80	109	24	196	447
Change	-11.5%	-11.2%	90.6%	-7.7%	42.9%	26.5%
	-5	-10	52	-2	59	94

The number of fixed-wing aircraft that are maintained at the O-level dropped by 54 aircraft or 5.4 percent; however, the rotary aircraft numbers have increased by 94 or 26.5 percent.

Number of aircraft models maintained

Another maintenance consideration is the number of different types of aircraft models that need to be maintained. The greater the number of different aircraft types, the more difficult it is to acquire and maintain experience and technical maintenance competency. Figure 6 shows the quantities relating the number of models maintained.

Table 5 provides a summary of the total column in figure 6.

Figure 6. Number of Navy aircraft models maintained by squadrons, FY 2004 to FY 2012

Number of models maintained													
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	10	2	1	11	1	3	3	2	8	2	1	2	1	47
2005	9	2	1	8	1	3	5	1	5	3	1	2	1	42
2006	9	1	1	7	1	3	6	1	4	3	2	2	1	41
2007	8	1	1	8	1	3	6	1	4	2	2	2	1	40
2008	7	1	2	8	2	3	4	1	3	2	2	2	1	38
2009	7	1	2	8	2	3	4	1	3	2	3	2	1	39
2010	7	1	1	7	1	3	4	1	3	2	2	2	1	35
2011	7	1	1	7	1	3	3	1	3	2	2	2	1	34
2012	7	2	1	7	1	3	4	1	3	4	2	2	2	39
Change	-30.0%	0.0%	0.0%	-36.4%	0.0%	0.0%	33.3%	-50.0%	-62.5%	100.0%	100.0%	0.0%	100.0%	-17.0%
	-3	0	0	-4	0	0	1	-1	-5	2	1	0	1	-8

Table 5. Navy aircraft models maintained, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
47	39	34	-17.0%	-8	4	0.09

The number of different models maintained trended down by 17.0 percent (8 fewer models). The increased standardization will help improve the maintenance support rates over the long term. Figures 7 and 8 provide the breakout between fixed-wing and rotary squadrons.

Figure 7. Number of fixed-wing models maintained

Number of fixed-wing models maintained									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	1	1	3	11	2	3	2	10	33
2005	1	1	5	8	2	3	1	9	30
2006	1	1	6	7	1	3	1	9	29
2007	1	1	6	8	1	3	1	8	29
2008	2	2	4	8	1	3	1	7	28
2009	2	2	4	8	1	3	1	7	28
2010	1	1	4	7	1	3	1	7	25
2011	1	1	3	7	1	3	1	7	24
2012	1	1	4	7	2	3	1	7	26
Change	0.0%	0.0%	33.3%	-36.4%	0.0%	0.0%	-50.0%	-30.0%	-21.2%
	0	0	1	-4	0	0	-1	-3	-7

Figure 8. Number of rotary models maintained

Number of rotary models maintained						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	2	2	1	1	8	14
2005	2	3	1	1	5	12
2006	2	3	2	1	4	12
2007	2	2	2	1	4	11
2008	2	2	2	1	3	10
2009	2	2	3	1	3	11
2010	2	2	2	1	3	10
2011	2	2	2	1	3	10
2012	2	4	2	2	3	13
Change	0.0%	100.0%	100.0%	100.0%	-62.5%	-7.1%
	0	2	1	1	-5	-1

The number of models maintained for the fixed-wing squadrons dropped by seven or 21.2 percent. The rotary squadrons only reduced their inventory by one model or 7.1 percent.

Average age of aircraft maintained

We calculated the average age of the aircraft assigned to each squadron as of the end of each fiscal year. Figure 9 provides the results.

Figure 9. Average age of Navy aircraft maintained by squadrons, FY 2004 to FY 2012

Average age in months														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	AVERAGE
2004	147.3	321.7	268.1	209.4	108.4	300.5	271.8	359.5	217.8	215.6	194.2	131.6	153.5	202.5
2005	139.6	325.0	278.9	198.5	102.3	266.4	283.9	319.6	165.1	220.5	205.2	137.7	165.5	191.1
2006	126.6	319.6	277.3	203.1	100.8	273.6	277.9	330.2	169.3	231.6	190.0	150.9	171.9	189.7
2007	133.9	330.7	276.4	204.2	100.0	286.7	297.8	345.2	145.5	216.3	203.6	164.2	188.0	191.8
2008	135.1	353.6	266.5	227.1	106.5	299.5	324.1	360.6	131.2	229.4	187.4	174.5	203.0	195.4
2009	143.2	349.4	244.7	226.8	90.8	311.1	331.6	378.6	130.2	240.5	150.0	189.9	215.5	193.8
2010	148.5	361.1	219.9	237.8	126.7	320.6	288.6	395.8	118.5	250.4	110.6	199.5	228.3	197.7
2011	165.4	377.2	222.1	236.5	139.7	337.0	273.2	401.2	114.1	229.6	94.6	212.1	243.8	200.3
2012	171.1	367.9	209.9	233.3	154.7	359.8	289.9	412.3	107.4	214.2	84.9	222.3	254.4	203.9
Change	16.2%	14.4%	-21.7%	11.4%	42.8%	19.7%	6.7%	14.7%	-50.7%	-0.7%	-56.3%	69.0%	65.7%	0.7%
	23.8	46.2	-58.2	23.9	46.4	59.2	18.2	52.8	-110.4	-1.4	-109.3	90.8	100.9	1.4

Table 6 provides a summary of the average column from figure 9.

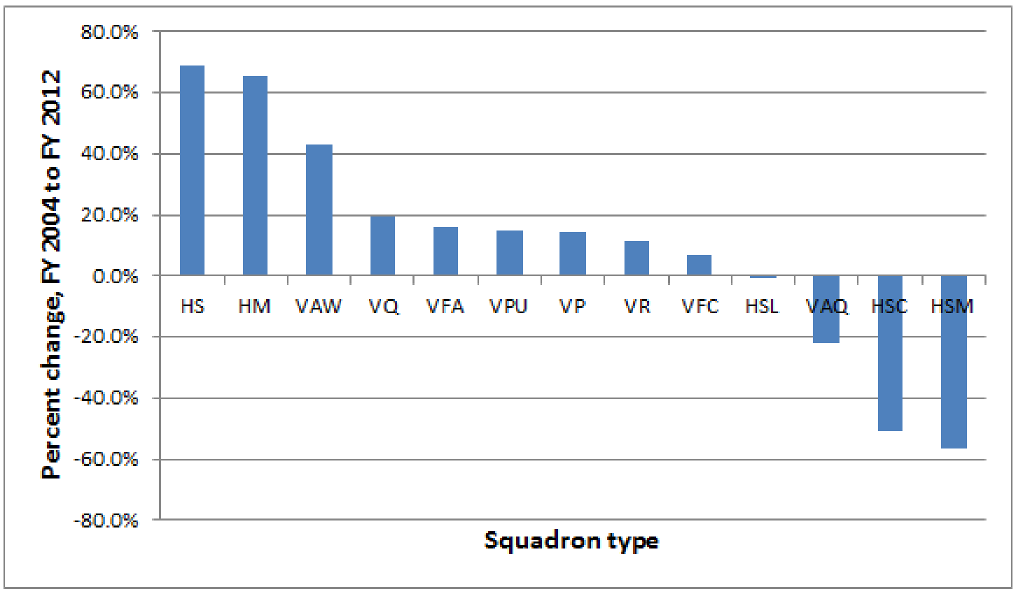
The average age of aircraft maintained by the squadrons has grown older, with an increase of 0.7 percent or by 1.4 months between FY 2004 and FY 2012. There has not been large variations in annual total

Table 6. Navy aircraft average age, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
203.9	196.2	189.7	0.7%	1.4	5.1	0.03

aircraft average age numbers during this period. The aging was not equally distributed among the squadron types, however. Figure 10 shows the variation between types of squadrons.

Figure 10. Change in Navy aircraft average age, from FY 2004 to FY 2012 by squadron type



The majority of new aircraft are being introduced into the electronic attack (VAQ), sea combat (HSC), and maritime strike (HSM) communities with the build up of EA-18G, MH-60S, and MH-60R inventories. However, the majority of aircraft by type are in the strike fighter (VFA) squadrons and their maintained aircraft aged by 23.8 months or 16.2 percent. Since a larger proportion of aircraft are in the VFA squadrons, this suggests that, with older aircraft to maintain, the overall maintenance support rates could decrease.

Figures 11 and 12 provide the breakout between fixed-wing and rotary squadrons.

Figure 11. Squadron fixed-wing aircraft average age

Squadron fixed-wing aircraft average age									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	108.4	268.1	271.8	209.4	321.7	300.5	359.5	147.3	204.3
2005	102.3	278.9	283.9	198.5	325.0	266.4	319.6	139.6	197.5
2006	100.8	277.3	277.9	203.1	319.6	273.6	330.2	126.6	194.0
2007	100.0	276.4	297.8	204.2	330.7	286.7	345.2	133.9	200.6
2008	106.5	266.5	324.1	227.1	353.6	299.5	360.6	135.1	206.8
2009	90.8	244.7	331.6	226.8	349.4	311.1	378.6	143.2	205.1
2010	126.7	219.9	288.6	237.8	361.1	320.6	395.8	148.5	211.7
2011	139.7	222.1	273.2	236.5	377.2	337.0	401.2	165.4	219.8
2012	154.7	209.9	289.9	233.3	367.9	359.8	412.3	171.1	226.2
Change	42.8%	-21.7%	6.7%	11.4%	14.4%	19.7%	14.7%	16.2%	10.7%
	46.4	-58.2	18.2	23.9	46.2	59.2	52.8	23.8	21.9

Figure 12. Squadron rotary aircraft average age

Squadron rotary aircraft average age						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	131.6	215.6	194.2	153.5	217.8	197.8
2005	137.7	220.5	205.2	165.5	165.1	174.7
2006	150.9	231.6	190.0	171.9	169.3	180.0
2007	164.2	216.3	203.6	188.0	145.5	170.2
2008	174.5	229.4	187.4	203.0	131.2	167.5
2009	189.9	240.5	150.0	215.5	130.2	166.8
2010	199.5	250.4	110.6	228.3	118.5	162.4
2011	212.1	229.6	94.6	243.8	114.1	154.9
2012	222.3	214.2	84.9	254.4	107.4	152.5
Change	69.0%	-0.7%	-56.3%	65.7%	-50.7%	-22.9%
	90.8	-1.4	-109.3	100.9	-110.4	-45.2

Even though the overall average age of the inventory did not change much, there are marked differences between fixed-wing and rotary squadrons. The two communities offset each other: fixed-wing inventory *increased* its average age by 21.9 months, or 10.7 percent, while the rotary aircraft inventory *reduced* its average age by 45.2 months, or 22.9 percent. Given the differences in number of aircraft (about twice as many fixed-wing as rotary), the resulting net change to the total inventory is minimal.

Total aircraft flying hours

We looked at the total flying hours of the aircraft assigned to each squadron as of the end of each fiscal year in order to determine how many annual hours the aircraft were flown. Figure 13 provides the results.

Figure 13. Total annual squadron aircraft flying hours, FY 2004 to FY 2012

Total aircraft flying hours

FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	173,350	53,600	24,059	62,459	17,215	18,956	7,805	3,070	53,802	33,241	23,046	19,064	6,924	496,591
2005	185,342	49,281	29,214	58,836	19,095	21,067	7,716	3,081	58,620	33,047	21,494	13,673	6,762	507,228
2006	197,839	48,547	31,909	56,084	17,036	19,262	9,441	3,080	48,008	31,741	22,946	16,512	5,254	507,659
2007	196,357	48,701	32,771	58,173	20,163	18,209	10,559	3,879	50,500	36,955	25,242	17,417	6,208	525,133
2008	195,230	32,743	29,586	55,466	17,873	14,635	11,532	5,750	52,451	33,197	26,841	15,306	6,854	497,464
2009	186,270	46,675	28,437	57,974	18,527	12,231	10,862	5,657	58,401	34,690	29,419	15,798	5,870	510,811
2010	189,683	56,385	30,172	55,714	17,795	16,701	11,448	4,390	61,148	32,011	35,316	16,704	5,781	533,248
2011	177,281	65,990	35,737	54,607	19,825	20,662	11,954	5,254	66,092	36,209	38,926	17,846	7,407	557,789
2012	175,273	65,987	33,051	51,455	18,882	21,163	10,605	6,225	68,763	32,910	39,927	16,743	6,476	547,460
Change	1.1%	23.1%	37.4%	-17.6%	9.7%	11.6%	35.9%	102.8%	27.8%	-1.0%	73.3%	-12.2%	-6.5%	10.2%
	1,923	12,387	8,992	-11,004	1,667	2,207	2,800	3,155	14,961	-331	16,881	-2,321	-448	50,869

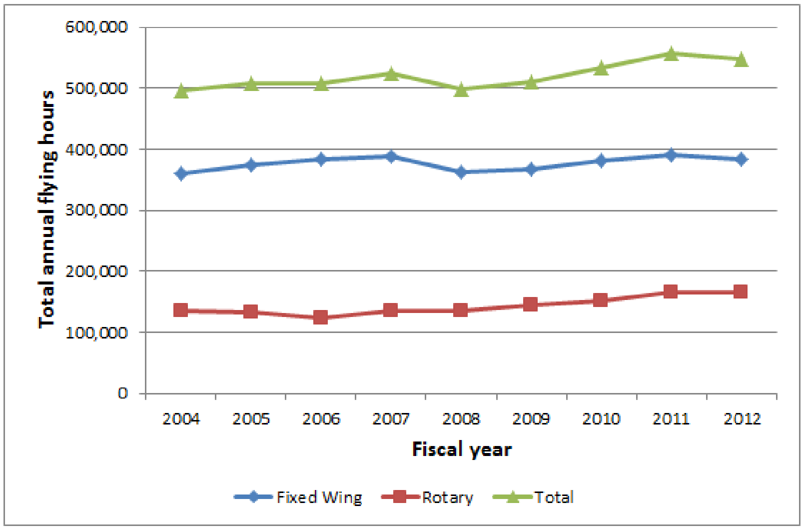
Table 7 provides a summary of the total column from figure 13.

Table 7. Navy annual flying hours, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
557,789	520,376	496,591	10.2%	50,869	21,904	0.04

Total annual flying hours increased by 10.2 percent or by 50,869 hours between FY 2004 and FY 2012. Figure 14 shows the year-to-year changes by aircraft class.

Figure 14. Navy annual flying hours by aircraft class timeline, FY 2004 to FY 2012

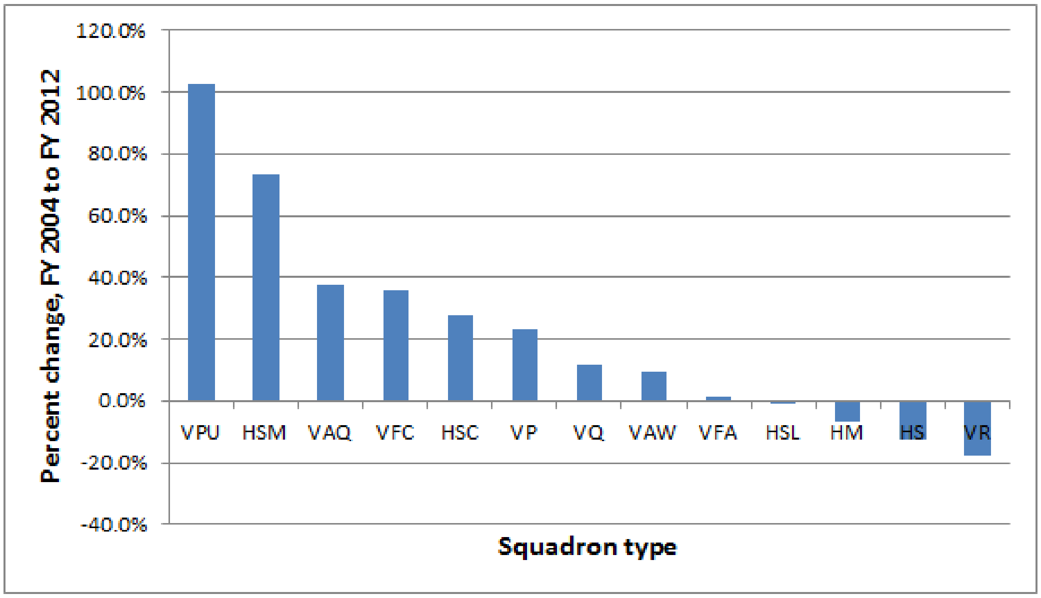


The year-to-year changes are fairly consistent with the exception of a sharp dip in fixed-wing flying hours in FY 2008, This drop was generated mostly by the VP community. The Navy continually conducts structural engineering and analysis of aircraft fatigue data under the Fatigue Life Management Program (FLMP). Ongoing analysis led to the grounding of 39 P-3C aircraft in December 2007 for concerns about fatigue damage in portions of the lower outer wing. This led the Navy to develop a comprehensive recovery plan that included accelerated FLMP efforts, use of on-hand material to immediately begin required modifications, and a dual-path approach to recovery that included both installation of complete outer wings and targeted material replacements.[2] This effort resulted in reduced annual flight hours for patrol (VP) squadrons in FY 2008.

2. From the NAVAIR logistics website which is found at: http://www.navair.navy.mil/index.cfm?fuseaction=home.displayPlatform&key=3397BCA7-FC7A-4D95-88B2-79CE4A36D8BD.

While the trend has shown a growing number for total annual flying hours, the increase is not equally distributed between the squadron types. Figure 15 shows the variation.

Figure 15. Change in total Navy aircraft flying hours, FY 2004 to FY 2012 by squadron type



The number of annual flight hours increased for the majority of squadrons. The only ones with reduced hours were the antisubmarine light (HSL), mine countermeasures (HM), antisubmarine (HS), and logistic support (VR) squadrons. Figures 16 and 17 provide the breakout between fixed-wing and rotary squadrons.

Annual flying hours have increased for both communities, but more so for the rotary squadrons. This is partially due to the increased number of aircraft in the inventory as well as to increased fleet demand. The annual operational tempo of the fixed-wing squadrons increased by 22,127 hours or 6.1 percent. The operational tempo of the rotary squadrons increased by 28,742 hours or by 21.1 percent. Even though the increase in hours is similar, the percentage increase is more than three times greater because there are fewer aircraft in the rotary inventory.

Figure 16. Total annual fixed-wing aircraft flying hours

Total fixed-wing aircraft flying hours									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	17,215	24,059	7,805	62,459	53,600	18,956	3,070	173,350	360,514
2005	19,095	29,214	7,716	58,836	49,281	21,067	3,081	185,342	373,632
2006	17,036	31,909	9,441	56,084	48,547	19,262	3,080	197,839	383,198
2007	20,163	32,771	10,559	58,173	48,701	18,209	3,879	196,357	388,812
2008	17,873	29,586	11,532	55,466	32,743	14,635	5,750	195,230	362,815
2009	18,527	28,437	10,862	57,974	46,675	12,231	5,657	186,270	366,633
2010	17,795	30,172	11,448	55,714	56,385	16,701	4,390	189,683	382,288
2011	19,825	35,737	11,954	54,607	65,990	20,662	5,254	177,281	391,310
2012	18,882	33,051	10,605	51,455	65,987	21,163	6,225	175,273	382,641
Change	9.7%	37.4%	35.9%	-17.6%	23.1%	11.6%	102.8%	1.1%	6.1%
	1,667	8,992	2,800	-11,004	12,387	2,207	3,155	1,923	22,127

Figure 17. Total annual rotary aircraft flying hours

Total rotary aircraft flying hours						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	19,064	33,241	23,046	6,924	53,802	136,077
2005	13,673	33,047	21,494	6,762	58,620	133,596
2006	16,512	31,741	22,946	5,254	48,008	124,461
2007	17,417	36,955	25,242	6,208	50,500	136,321
2008	15,306	33,197	26,841	6,854	52,451	134,649
2009	15,798	34,690	29,419	5,870	58,401	144,178
2010	16,704	32,011	35,316	5,781	61,148	150,960
2011	17,846	36,209	38,926	7,407	66,092	166,479
2012	16,743	32,910	39,927	6,476	68,763	164,819
Change	-12.2%	-1.0%	73.3%	-6.5%	27.8%	21.1%
	-2,321	-331	16,881	-448	14,961	28,742

Summary of changes

Figure 18 provides a comparison of the percent change for each of the factors from FY 2004 to FY 2012. Figure 19 provides the same information but on a timeline that shows the index change each year when compared to the baseline year of FY 2004.

Figure 18. Navy squadron characteristics percent change factor summary, FY 2004 to FY 2012

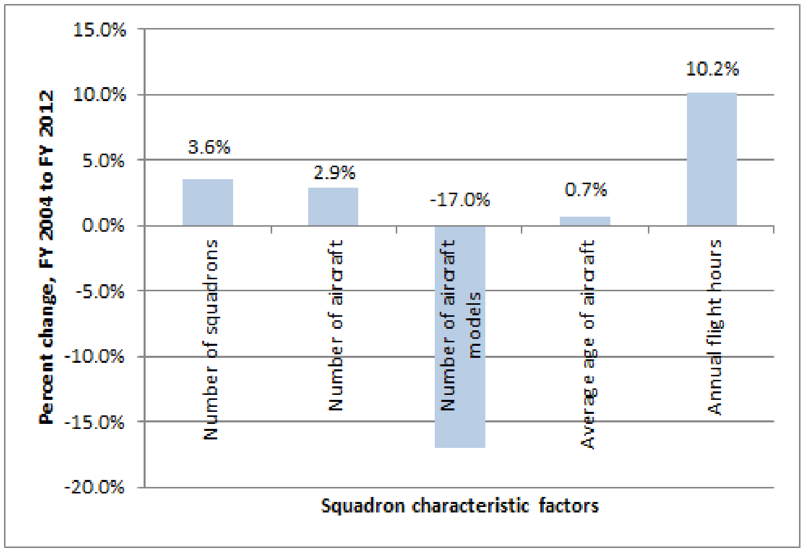
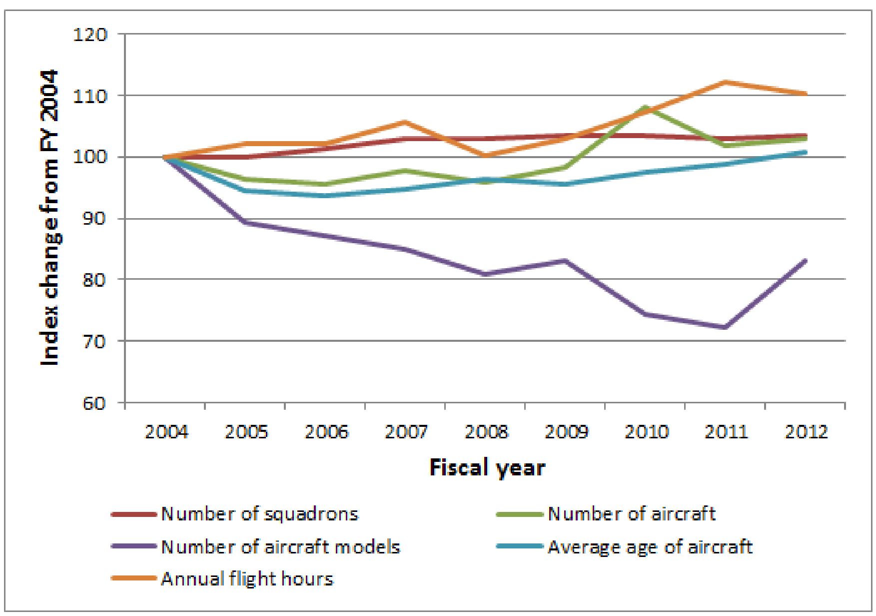


Figure 19. Navy squadron characteristics index change timeline, FY 2004 to FY 2012



Maintenance factor variables

Nine fields capture the variables that influence maintenance support rates. They can be divided into three groups: squadron maintenance manpower availability, maintenance personnel experience levels, and outside technical support by NATEC. We looked at all nine fields to determine the extent of change over the nine years.

Number of maintainers

Since our focus is only on aviation maintenance aspects, we separated personnel dedicated to aircraft maintenance from other personnel assigned to a squadron. We only included enlisted rates E1 through E6 since they perform the majority of hands-on maintenance. Table 8 shows the ratings we included.

Table 8. Navy enlisted aviation maintenance ratings

Designator	Rating name
AD	Aviation Machinist's Mate
AE	Aviation Electrician's Mate
AM	Aviation Mechanic
AME	Aviation Structural Mechanic, Safety Equipment
AN	Airman
AO	Aviation Ordnanceman
AT	Aviation Electronics Technician
PR	Aircrew Survival Equipmentman

Figure 20 shows the number of aviation maintainers in each of the squadrons.

Table 9 provides a summary of the total column from figure 20.

The total number of O-level squadron aircraft maintainers dropped steadily, with a total decrease in manpower of 27.0 percent or 5,597 personnel between FY 2004 and FY 2012. There were moderate variations in total numbers during the period. The staffing reduction was not equally distributed among the squadron types, however. Figure 21 shows the variation.

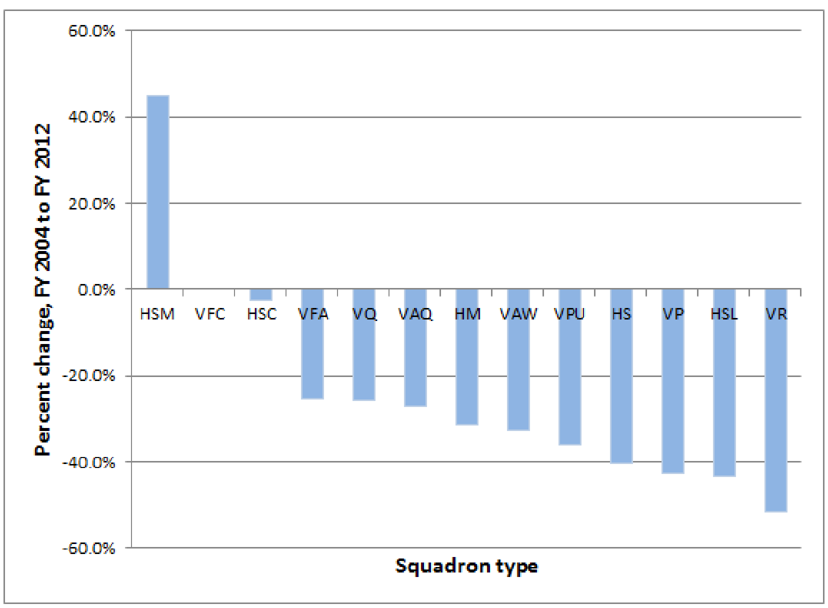
Figure 20. Total number of Navy squadron maintainers, FY 2004 to FY 2012

Total number of maintainers														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	7,237	3,184	2,173	1,185	1,078	276	109	236	2,011	1,093	748	685	744	20,759
2005	7,090	3,160	2,190	1,204	1,084	299	109	233	2,184	1,203	848	714	718	21,036
2006	6,905	3,119	2,083	1,279	1,042	267	113	234	2,143	1,224	880	713	637	20,639
2007	6,459	2,807	1,899	1,272	961	252	111	235	1,949	1,215	958	662	561	19,341
2008	6,075	2,648	1,781	1,211	851	224	112	238	1,850	1,246	1,060	639	566	18,501
2009	5,917	2,131	1,744	811	844	174	116	173	1,880	1,220	1,170	609	550	17,339
2010	6,098	2,190	1,677	836	829	173	105	176	1,888	1,233	1,160	605	564	17,534
2011	5,958	2,015	1,667	749	806	161	114	168	2,006	1,036	1,165	592	554	16,991
2012	5,404	1,827	1,583	573	726	205	109	151	1,960	621	1,084	408	511	15,162
Change	-25.3%	-42.6%	-27.2%	-51.6%	-32.7%	-25.7%	0.0%	-36.0%	-2.5%	-43.2%	44.9%	-40.4%	-31.3%	-27.0%
	-1,833	-1,357	-590	-612	-352	-71	0	-85	-51	-472	336	-277	-233	-5,597

Table 9. Navy squadron maintainers, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
21,036	18,589	15,162	-27.0%	-5,597	2,014	0.11

Figure 21. Change in Navy squadron maintainers, FY 2004 to FY 2012 by squadron type



All squadrons lost at least 20 percent of their maintenance personnel, with the exception of maritime strike (HSM), sea combat (HSC), and fighter composite (VFC) squadrons.

Maintenance personnel FILL rate

Although the manning reductions are quite steep for most squadrons, they may not be as significant if the billets authorized numbers are also being reduced. The maintenance personnel FILL rate is calculated by dividing the total number of unit maintenance personnel on-board by the total number of maintenance billets authorized during the fiscal year.

Figure 22 shows the average manpower FILL rates in each of the squadrons.

Figure 22. Average Navy squadron maintenance FILL rates, FY 2004 to FY 2012

Average maintenance FILL rates														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	AVERAGE
2004	110.2%	105.2%	109.0%	103.0%	109.7%	107.0%	104.8%	91.1%	120.1%	113.4%	110.5%	105.7%	102.9%	109.2%
2005	114.7%	106.7%	120.4%	102.5%	124.9%	115.9%	104.8%	91.3%	116.9%	101.3%	110.0%	119.1%	114.4%	112.8%
2006	110.5%	106.0%	116.2%	108.2%	120.1%	103.5%	108.7%	92.8%	119.6%	104.3%	111.6%	120.9%	108.7%	111.9%
2007	103.9%	112.3%	105.9%	108.3%	114.0%	97.7%	106.7%	93.2%	111.6%	103.8%	117.5%	108.9%	95.7%	107.7%
2008	100.0%	109.0%	101.7%	112.4%	125.1%	86.8%	107.7%	94.4%	105.3%	105.7%	102.1%	110.9%	99.8%	105.9%
2009	97.9%	116.8%	101.8%	116.0%	115.4%	67.4%	111.5%	96.1%	105.7%	104.1%	109.9%	110.3%	96.8%	106.0%
2010	98.2%	164.0%	98.8%	135.9%	111.8%	67.1%	101.0%	95.7%	105.0%	104.8%	106.1%	107.8%	99.1%	112.5%
2011	96.3%	102.8%	97.3%	116.3%	114.0%	62.4%	109.6%	91.2%	103.4%	100.0%	104.3%	105.5%	97.2%	102.3%
2012	89.3%	100.4%	90.6%	106.8%	95.9%	79.5%	104.8%	83.4%	93.9%	96.5%	95.9%	92.2%	90.0%	94.3%
Change	-19.0%	-4.6%	-16.9%	3.7%	-12.6%	-25.7%	0.0%	-8.5%	-21.9%	-14.9%	-13.2%	-12.7%	-12.6%	-13.6%
	-20.9%	-4.8%	-18.5%	3.8%	-13.8%	-27.5%	0.0%	-7.7%	-26.3%	-16.9%	-14.5%	-13.5%	-12.9%	-14.9%

Table 10 provides a summary of the average column. from figure 22

Table 10. Navy squadron maintenance FILL rate, average number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
112.8%	106.9%	94.3%	-13.6%	-14.9%	5.9%	0.06

Given that the total number of O-level squadron aircraft maintainers dropped steadily, with a total decrease in manpower of 27.0 percent or 5,597 personnel between FY 2004 and FY 2012, it makes sense that the overall FILL rates also dropped. However, since the overall FILL rate only dropped by 14.9 percent, this would indicate that there has also been reductions in authorized billets.

Maintenance personnel billets

We drilled down to look at squadron authorized billets for the same period. Figure 23 shows the authorized maintenance billets.

Figure 23. Navy squadron authorized maintenance billets, FY 2004 to FY 2012

Total maintainer billets authorized														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	6,638	3,013	2,004	1,154	983	258	104	259	1,911	967	680	658	723	19,352
2005	6,200	2,977	1,823	1,199	868	258	104	255	2,031	1,199	776	605	635	18,930
2006	6,234	2,923	1,813	1,195	868	258	104	252	2,207	1,186	794	588	587	19,009
2007	6,240	2,781	1,813	1,181	870	258	104	252	1,774	1,186	855	610	587	18,511
2008	5,984	2,613	1,734	1,158	869	258	104	252	1,760	1,186	1,040	571	568	18,097
2009	5,974	2,101	1,693	752	869	258	104	180	1,785	1,186	1,063	549	568	17,082
2010	6,147	1,925	1,686	689	889	258	104	184	1,792	1,180	1,093	553	569	17,069
2011	6,088	1,965	1,723	680	842	258	104	184	1,958	1,043	1,119	555	569	17,088
2012	6,011	1,860	1,741	571	846	258	104	181	2,064	662	1,129	442	569	16,438
Change	-9.4%	-38.3%	-13.1%	-50.5%	-13.9%	0.0%	0.0%	-30.1%	8.0%	-31.5%	66.0%	-32.8%	-21.3%	-15.1%
	-627	-1,153	-263	-583	-137	0	0	-78	153	-305	449	-216	-154	-2,914

Table 11 provides a summary of the total column from figure 23.

Table 11. Navy squadron authorized maintenance billets, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
19,352	17,953	16,438	-15.1%	-2,914	1,057	0.06

The table shows a decline in authorized billets of 15.1 percent during the same period. This explains about half of the drop in maintainer manpower.

Number of total enlisted

We next looked at the squadron total enlisted inventory change to determine whether the maintainer reductions were similar or different from the rest of the squadron's enlisted personnel. Figure 24 shows the total enlisted inventory for the same time period.

Figure 24. Navy squadron total enlisted inventory, FY 2004 to FY 2012

Total number of enlisted														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	9,494	4,952	2,886	1,721	1,487	413	145	405	2,899	1,730	1,154	1,090	1,062	29,438
2005	9,512	4,933	2,964	1,746	1,542	423	141	385	3,209	1,861	1,318	1,170	1,046	30,250
2006	9,429	4,962	2,957	1,887	1,530	386	147	394	3,553	1,912	1,361	1,147	1,095	30,760
2007	8,880	4,569	2,752	1,885	1,506	368	146	401	3,262	1,874	1,525	1,140	992	29,300
2008	8,329	4,219	2,581	1,848	1,357	332	150	389	3,211	1,895	1,731	1,133	991	28,166
2009	8,144	4,133	2,524	1,687	1,341	355	154	389	3,239	1,888	1,854	1,064	1,002	27,774
2010	8,243	4,085	2,407	1,810	1,301	355	144	395	3,258	1,888	1,796	1,036	1,003	27,721
2011	8,031	4,066	2,387	1,687	1,242	348	152	370	3,444	1,586	1,760	1,008	985	27,066
2012	7,382	3,803	2,261	1,430	1,168	500	156	298	3,467	1,000	1,666	729	919	24,779
Change	-22.2%	-23.2%	-21.7%	-16.9%	-21.5%	21.1%	7.6%	-26.4%	19.6%	-42.2%	44.4%	-33.1%	-13.5%	-15.8%
	-2,112	-1,149	-625	-291	-319	87	11	-107	568	-730	512	-361	-143	-4,659

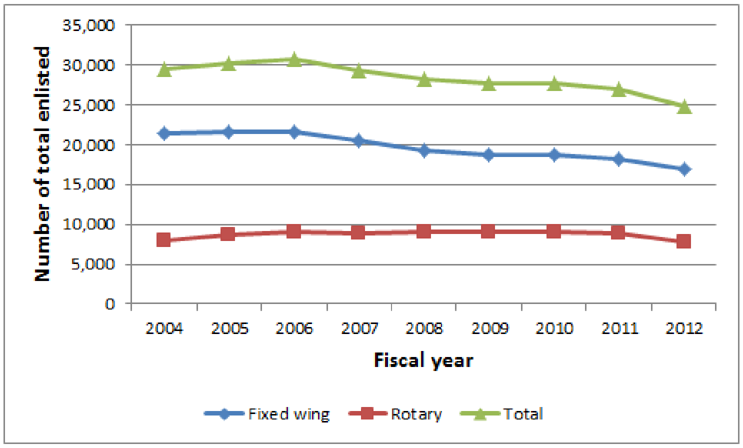
Table 12 provides a summary of the total column from figure 24.

Table 12. Navy squadron total enlisted inventory, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
30,760	28,362	24,779	-15.8%	-4,659	1,826	0.06

Figure 25 gives us the year to year trend lines for total Navy squadron enlisted manpower. It shows a steady decline in both fixed wing and rotary squadrons, with fixed wing squadrons reducing faster.

Figure 25. Navy squadron total number of enlisted, FY 2004 to FY 2012



We drilled deeper to see what the non-maintainer enlisted inventory by aviation type numbers were. Figure 26 shows the total non-maintainer enlisted inventory for the same time period.

Figure 26. Navy squadron total non-maintainer enlisted inventory, FY 2004 to FY 2012

Total number of non-maintainer enlisted														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	2,257	1,768	713	536	409	137	36	169	888	637	406	405	318	8,679
2005	2,422	1,773	774	542	458	124	32	152	1,025	658	470	456	328	9,214
2006	2,524	1,843	874	608	488	119	34	160	1,410	688	481	434	458	10,121
2007	2,421	1,762	853	613	545	116	35	166	1,313	659	567	478	431	9,959
2008	2,254	1,571	800	637	506	108	38	151	1,361	649	671	494	425	9,665
2009	2,227	2,002	780	876	497	181	38	216	1,359	668	684	455	452	10,435
2010	2,145	1,895	730	974	472	182	39	219	1,370	655	636	431	439	10,187
2011	2,073	2,051	720	938	436	187	38	202	1,438	550	595	416	431	10,075
2012	1,978	1,976	678	857	442	295	47	147	1,507	379	582	321	408	9,617
Change	-12.4%	11.8%	-4.9%	59.9%	8.1%	115.3%	30.6%	-13.0%	69.7%	-40.5%	43.3%	-20.7%	28.3%	10.8%
	-279	208	-35	321	33	158	11	-22	619	-258	176	-84	90	938

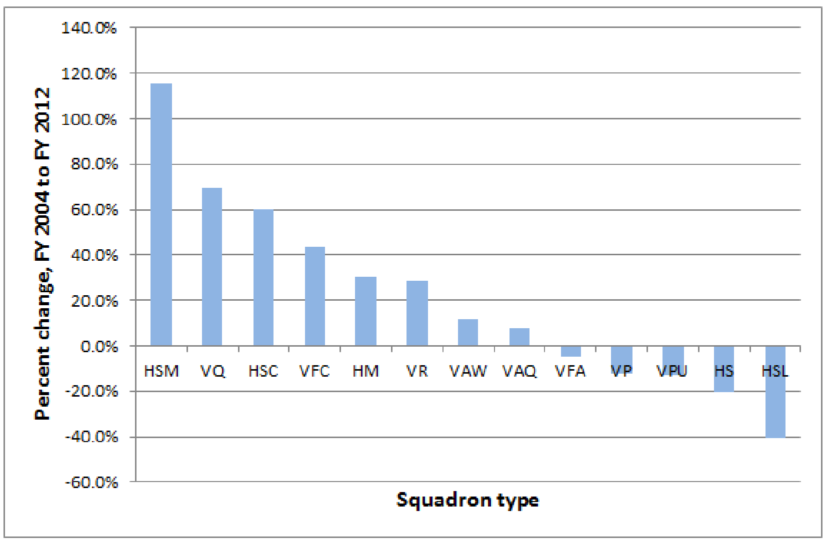
Table 13 provides a summary of the total column from figure 26.

Table 13. Navy squadron total non-maintainer enlisted inventory, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
10,435	9,772	8,679	10.8%	938	548	0.06

The total number of O-level squadron aircraft non-maintainers grew steadily, with a total increase in manpower of 10.8 percent or 938 personnel between FY 2004 and FY 2012. There were moderate variations in total numbers during the period. The non-maintainer increase was not equally distributed among the squadron types, however. Figure 27 shows the variation.

Figure 27. Change in Navy squadron non-maintainer numbers, FY 2004 to FY 2012 by squadron type



Navy squadron non-maintainer enlisted numbers grew in all squadrons except for the strike fighter (VFA), patrol (VP), special project (VPU), antisubmarine (HS), and antisubmarine light (HSL) communities.

Maintainer to total enlisted ratio

Table 12 shows that the decline in total aviation enlisted inventory is 15.8 percent; however, it still isn't clear whether this reduction is proportional to the maintenance manpower reductions. The growth of non-maintainer enlisted numbers is an indication that the reductions may not be proportional. So, we generated a ratio of maintainers to total enlisted field to see the change in proportions. Figure 28 shows this relationship.

Figure 28. Navy squadron ratio of maintainers to total enlisted, FY 2004 to FY 2012

Average ratio of maintainers-to-total enlisted

FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	AVERAGE
2004	75.7%	64.1%	74.7%	68.3%	72.5%	66.8%	75.2%	58.4%	67.8%	62.6%	65.4%	62.1%	70.0%	70.3%
2005	73.9%	64.3%	73.0%	68.8%	70.3%	70.7%	77.3%	60.5%	66.0%	63.8%	64.6%	60.4%	68.7%	69.3%
2006	72.5%	62.4%	69.7%	67.6%	68.1%	69.2%	76.9%	59.4%	60.3%	63.0%	64.6%	61.1%	58.2%	67.0%
2007	72.3%	60.2%	68.3%	67.2%	60.0%	68.5%	76.0%	58.6%	59.2%	63.8%	63.2%	57.4%	56.6%	65.6%
2008	72.5%	61.1%	68.4%	65.6%	59.3%	67.5%	74.7%	61.2%	57.5%	64.8%	61.5%	56.5%	57.1%	65.4%
2009	72.4%	49.3%	68.8%	46.4%	59.5%	49.0%	75.3%	44.6%	57.9%	63.8%	63.0%	57.0%	54.8%	61.6%
2010	73.8%	52.7%	69.0%	43.3%	60.2%	48.7%	72.9%	44.6%	57.7%	64.3%	64.7%	58.1%	56.2%	62.3%
2011	73.7%	49.0%	69.2%	42.6%	61.3%	46.3%	75.0%	45.3%	58.5%	64.1%	66.4%	58.3%	56.3%	62.1%
2012	72.9%	47.8%	69.6%	38.8%	58.4%	41.0%	69.9%	50.7%	56.8%	60.6%	65.4%	56.0%	55.6%	61.0%
Change	-3.8%	-25.5%	-6.8%	-43.2%	-19.5%	-38.6%	-7.1%	-13.2%	-16.2%	-3.3%	0.0%	-9.8%	-20.6%	-13.1%
	-2.9%	-16.3%	-5.0%	-29.5%	-14.1%	-25.8%	-5.3%	-7.7%	-11.0%	-2.0%	0.0%	-6.1%	-14.4%	-9.2%

Table 14 provides a summary of the average column from figure 28.

Table 14. Navy squadron authorized maintenance billets, average number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
70.3%	64.9%	61.0%	-13.1%	-9.2%	3.4%	0.05

This table shows that there was a change in the ratio between aircraft maintainers and the rest of the enlisted personnel in the squadrons. The maintainer inventory was reduced 13.1 percent more than the rest of the enlisted population. Given this information, we looked at the maintenance rating and rate distributions to determine whether there were differences between them or whether the reductions were evenly spread. Figure 29 shows the numbers of maintainers by rate.

Figure 29. Navy squadron total maintenance manpower by rate, FY 2004 to FY 2012

Total maintenance manpower by rate									
FY	AD	AE	AM	AME	AN	AO	AT	PR	TOTAL
2004	3,340	2,875	4,524	1,127	3,106	1,863	3,223	701	20,759
2005	3,433	2,860	4,869	1,124	2,760	2,072	3,165	753	21,036
2006	3,619	2,648	4,955	1,112	2,378	2,060	3,021	846	20,639
2007	3,706	2,662	4,962	1,077	925	2,008	3,179	822	19,341
2008	3,654	2,595	4,735	1,093	279	2,000	3,302	843	18,501
2009	3,451	2,322	4,518	1,035	135	2,044	2,982	852	17,339
2010	3,328	2,347	4,437	1,019	397	2,158	2,991	857	17,534
2011	3,113	2,361	4,105	945	672	2,144	2,832	819	16,991
2012	2,690	2,084	3,562	889	702	1,967	2,542	726	15,162
Change	-19.5%	-27.5%	-21.3%	-21.1%	-77.4%	5.6%	-21.1%	3.6%	-27.0%
	-650	-791	-962	-238	-2,404	104	-681	25	-5,597

Table 15 provides a summary of the total column from figure 29.

Table 15. Navy squadron maintenance manpower by rate, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
21,036	18,589	15,162	-27.0%	-5,597	2,014	0.11

It is clear that the majority of maintenance manpower cuts were in the AN rate with a reduction of 2,404 or 77.4 percent. We examined the rating distributions to determine whether there were differences there as well. Figure 30 shows this information.

Figure 30. Navy squadron total maintenance manpower by rating, FY 2004 to FY 2012

Total maintenance manpower by grade					
FY	E1-E3	E4	E5	E6	TOTAL
2004	7,595	4,816	4,794	3,554	20,759
2005	7,431	5,115	4,953	3,537	21,036
2006	7,660	4,614	4,958	3,407	20,639
2007	6,088	4,775	5,073	3,405	19,341
2008	4,530	5,760	4,861	3,350	18,501
2009	4,816	5,024	4,629	2,870	17,339
2010	6,355	4,291	4,126	2,762	17,534
2011	6,389	4,092	3,741	2,769	16,991
2012	4,399	5,000	3,302	2,461	15,162
Change	-42.1%	3.8%	-31.1%	-30.8%	-27.0%
	-3,196	184	-1,492	-1,093	-5,597

Given the reduction of ANs, it is not surprising that the greatest reduction (42.1 percent) was in the E1 to E3 rating group. However, we also see some grade slide as the E4 rating group grew by 3.8 percent and both the E5 and E6 rating groups declined by over 30 percent. We next looked to determine whether these maintenance manpower inventory reductions have any effect on experience levels.

Maintenance personnel FIT rate

The FIT rate is the ratio of total unit personnel with Navy enlisted classification (NEC) certifications held to the total NEC requirements of a squadron during the year. We separated the NECs relating to aircraft maintenance to calculate FIT rates for just the maintenance personnel. The FIT rate provides us with an indication of the maintenance personnel who are maintaining their technical competency to perform the work. Figure 31 provides a breakdown of the average maintenance personnel FIT rates for each squadron type.

Figure 31. Navy squadron average maintenance manpower FIT rate, FY 2004 to FY 2012

Average maintenance FIT rates														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	AVERAGE
2004	77.9%	83.1%	89.9%	76.0%	88.0%	86.7%	73.1%	72.0%	84.7%	84.5%	85.2%	88.8%	74.4%	82.2%
2005	85.4%	87.5%	90.3%	71.0%	84.0%	91.2%	80.7%	75.4%	78.6%	80.4%	91.6%	93.9%	88.4%	84.0%
2006	88.7%	89.3%	88.5%	80.2%	86.8%	88.6%	89.3%	81.5%	73.1%	84.6%	88.5%	93.1%	81.1%	85.5%
2007	84.3%	87.6%	89.8%	90.1%	87.5%	84.2%	90.3%	87.6%	78.1%	85.5%	89.5%	91.1%	69.5%	85.9%
2008	89.8%	89.4%	80.2%	86.6%	88.6%	84.9%	86.0%	92.9%	81.8%	86.2%	77.2%	95.6%	86.4%	86.7%
2009	91.9%	87.1%	86.5%	78.8%	89.2%	95.6%	87.1%	89.7%	91.1%	81.8%	89.1%	90.3%	89.3%	88.1%
2010	87.3%	94.2%	82.8%	84.3%	88.0%	93.3%	74.2%	91.9%	88.4%	81.7%	75.7%	85.6%	89.1%	86.6%
2011	89.3%	88.8%	82.2%	76.9%	82.1%	98.0%	78.5%	85.2%	86.9%	87.5%	86.7%	91.0%	90.8%	86.0%
2012	87.4%	88.2%	80.4%	90.2%	78.7%	91.0%	80.7%	84.1%	90.5%	76.2%	81.2%	76.6%	82.6%	85.3%
Change	12.2%	6.2%	-10.6%	18.7%	-10.6%	5.0%	10.3%	16.7%	6.8%	-9.8%	-4.8%	-13.8%	11.0%	3.8%
	9.5%	5.1%	-9.5%	14.2%	-9.4%	4.3%	7.5%	12.1%	5.8%	-8.3%	-4.1%	-12.2%	8.2%	3.1%

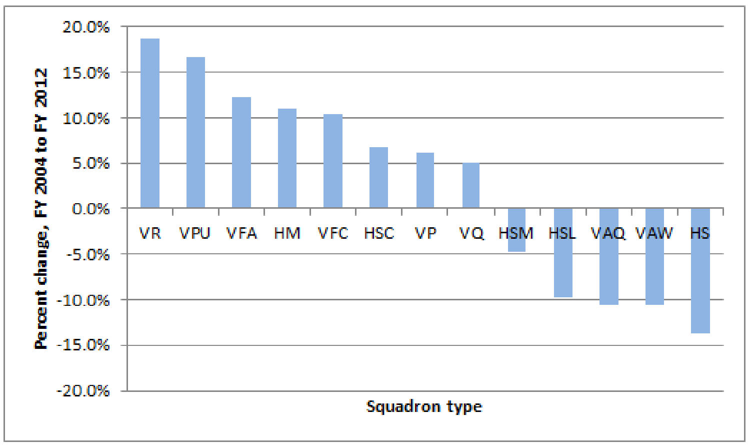
Table 16 provides a summary of the total column for figure 31.

Table 16. Navy squadron maintenance manpower FIT rate, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
88.1%	85.6%	82.2%	3.8%	3.1%	1.7%	0.02

From this table, we found that the average FIT rate for maintenance personnel improved slightly to 85.3 percent. This was a 3.8-percent improvement for the Navy; however, FIT rates did not improve for all aviation communities. There was some variation among communities, but not much as the coefficient of variation is only 0.02. Figure 32 shows the distribution between aviation communities.

Figure 32. Change in Navy squadron maintainer FIT rate, FY 2004 to FY 2012 by squadron type



Maintenance personnel time in unit

Given that we found a reduction in overall maintenance manpower, but no reduction in FIT rates, we next examined the experience levels in man-months for the personnel who remained in the squadrons. Since the total unit experience amount would be down due to the squadron manpower reductions, we chose to use average man-months per maintainer to demonstrate the actual experience level changes. Figure 33 provides the average time in unit for the maintenance personnel.

Figure 33. Navy squadron average maintainer time in unit, FY 2004 to FY 2012

Average maintenance personnel unit man-months of experience														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	AVERAGE
2004	18.5	21.3	18.3	21.7	18.5	22.8	19.4	21.3	13.6	2.2	9.4	17.9	19.9	17.4
2005	19.6	21.9	19.3	20.6	20.0	22.0	19.5	23.1	14.7	2.6	9.4	18.7	21.6	18.1
2006	20.5	22.0	20.6	22.3	21.1	23.7	22.5	21.6	13.2	2.8	10.4	20.0	20.4	18.7
2007	20.5	23.7	20.2	23.6	20.2	23.7	22.8	21.2	16.4	2.9	10.9	20.8	22.9	19.4
2008	20.7	23.5	20.7	24.1	21.7	25.3	20.7	21.5	19.0	3.1	10.4	20.5	22.2	19.8
2009	19.8	21.1	20.2	23.4	19.9	21.9	20.2	21.7	19.2	3.0	10.9	19.9	22.0	18.9
2010	18.7	19.1	19.8	23.6	19.4	20.3	22.7	22.1	19.6	3.1	13.4	16.9	20.6	18.4
2011	19.2	21.0	19.3	24.0	21.5	20.8	19.5	22.6	17.7	3.6	14.0	18.4	22.9	18.9
2012	20.9	22.8	19.9	22.2	20.8	19.4	18.1	15.3	19.0	3.6	15.3	19.5	23.1	19.8
Change	12.8%	7.1%	8.7%	2.5%	12.2%	-14.6%	-6.6%	-28.4%	39.3%	64.9%	63.0%	9.2%	15.8%	13.8%
	2.4	1.5	1.6	0.5	2.3	-3.3	-1.3	-6.0	5.4	1.4	5.9	1.6	3.1	2.4

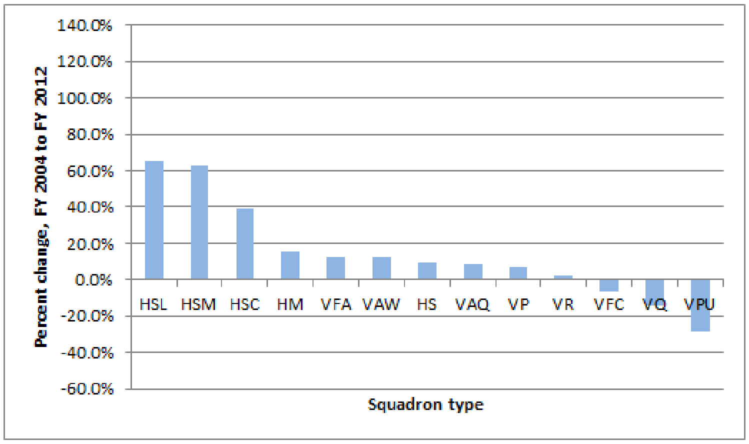
Table 17 provides a summary of the average column from figure 33.

Table 17. Navy squadron average maintainer time in unit, average number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
19.8	18.8	17.4	13.8%	2.4	0.8	0.04

The average maintainer time in unit increased by 13.8 percent or 2.4 man-months. Figure 34 shows the distribution across the aviation communities.

Figure 34. Change in Navy squadron average maintainer time in unit, FY 2004 to FY 2012 by squadron type



The average maintainer time in unit increased for all communities except for the reconnaissance (VQ), special project (VPU), and fighter composite (VFC) squadrons which all had more than a 6-percent reduction in average man-months.

Maintenance personnel career time in squadrons

We also examined the average man-months of career time the maintainers had in aviation squadrons as opposed to other duty assignments. Figure 35 shows this distribution.

Figure 35. Navy squadron average maintainer career time in squadrons, FY 2004 to FY 2012

Average maintenance personnel career squadron man-months of experience														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	AVERAGE
2004	38.8	50.7	40.5	72.1	38.4	47.3	58.7	58.4	37.3	9.4	28.5	41.5	43.9	42.5
2005	41.6	50.3	42.7	69.9	41.3	47.4	58.2	60.2	37.6	9.7	30.5	41.2	47.1	43.7
2006	42.4	50.1	44.2	70.0	43.7	47.8	58.7	57.0	38.8	10.8	30.7	42.6	41.9	44.3
2007	43.8	53.4	45.2	70.2	42.8	48.1	58.8	58.3	47.0	11.6	34.4	45.0	45.0	46.3
2008	45.7	56.8	47.0	69.4	49.9	49.6	54.1	63.0	49.8	11.3	36.8	47.8	43.8	48.4
2009	44.5	50.7	47.6	64.7	50.7	46.8	57.2	55.3	48.6	10.7	34.2	46.0	42.6	46.5
2010	43.4	50.3	47.3	61.5	51.8	46.3	57.2	60.1	49.9	12.2	36.9	42.8	40.7	46.1
2011	43.7	52.3	46.9	62.4	50.8	51.3	53.9	59.7	47.8	13.6	49.2	45.0	42.9	47.2
2012	44.5	53.0	45.1	60.3	48.7	53.1	55.5	50.9	48.0	19.8	52.9	42.3	43.3	47.4
Change	14.6%	4.6%	11.2%	-16.3%	26.6%	12.2%	-5.5%	-12.9%	28.6%	112.2%	86.0%	2.0%	-1.3%	11.6%
	5.7	2.3	4.6	-11.8	10.2	5.8	-3.2	-7.5	10.7	10.5	24.5	0.8	-0.6	4.9

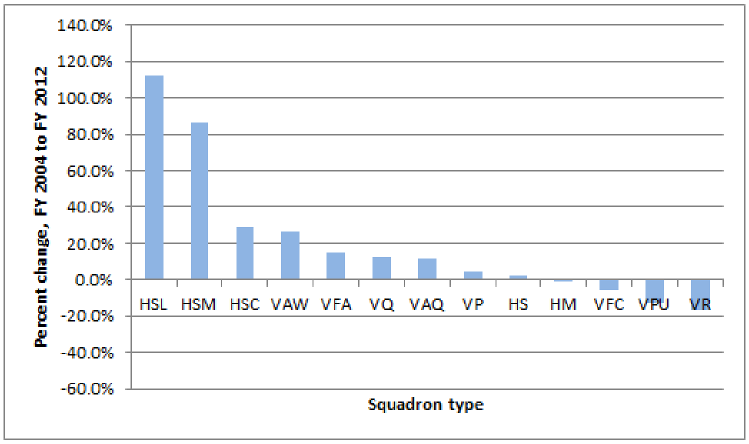
Table 18 provides a summary of the average column from figure 35.

Table 18. Navy squadron average maintainer career time in squadrons, average number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
48.4	45.8	42.5	11.6%	4.9	1.9	0.04

The average maintainer career time in squadrons increased—by 11.6 percent or 4.9 man-months. There was some variation over the nine-year period for the Navy. However, the different aviation communities had more variation and change among themselves. Figure 36 shows the differences across the aviation communities.

Figure 36. Change in Navy squadron average maintainer career time in squadrons, FY 2004 to FY 2012 by squadron type



Maintenance personnel career time servicing T/M/S

We also examined the average career time each maintainer had with the T/M/S aircraft in the squadron's inventory that year. Figure 37 shows the results.

Figure 37. Navy squadron average maintainer career time with T/M/S, FY 2004 to FY 2012

Average maintenance personnel career T/M/S man-months of experience														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	AVERAGE
2004	51.2	63.1	45.8	117.5	39.5	186.6	77.6	106.8	103.9	241.2	271.5	79.2	175.6	88.9
2005	52.3	67.3	50.4	100.6	43.9	126.6	81.3	92.3	95.1	237.8	271.5	98.3	203.9	88.1
2006	51.3	67.1	54.2	104.4	48.3	116.5	93.2	90.1	93.3	254.0	276.1	112.8	244.5	91.2
2007	57.8	73.1	59.0	109.6	71.8	108.9	98.1	91.4	92.2	243.6	230.3	126.5	307.3	96.5
2008	58.7	78.0	60.3	113.9	70.6	115.9	25.8	99.2	116.5	243.9	197.0	134.3	334.9	99.9
2009	54.9	94.5	58.3	248.9	76.2	144.5	30.8	133.5	123.4	232.5	172.2	126.9	351.7	115.4
2010	47.8	82.8	55.1	148.0	72.1	159.2	37.5	136.7	131.5	219.2	145.1	103.1	324.7	97.7
2011	46.0	91.7	46.2	159.9	75.0	197.6	35.1	139.6	127.4	226.6	136.8	108.2	331.7	97.9
2012	54.7	104.6	42.4	179.8	82.2	256.6	79.4	102.8	128.4	234.3	103.9	112.1	312.2	99.6
Change	7.0%	65.8%	-7.5%	53.0%	107.8%	37.5%	2.3%	-3.7%	23.6%	-2.9%	-61.7%	41.5%	77.7%	12.0%
	3.6	41.5	-3.4	62.3	42.6	70.0	1.8	-3.9	24.5	-6.9	-167.6	32.9	136.5	10.7

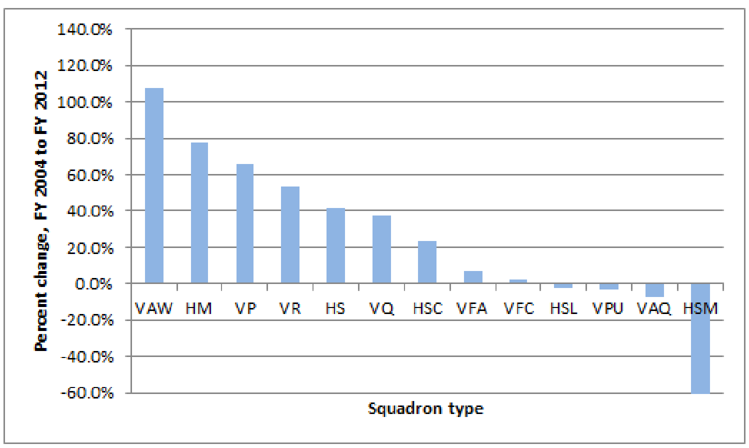
Table 19 provides a summary of the average column from figure 37.

Table 19. Navy squadron average maintainer career time with T/M/S, average number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
115.4	97.3	88.1	12.0%	10.7	8.2	0.08

The average maintainer career time with T/M/S increased—by 12.0 percent or 10.7 man-months. There was a fair amount of variation over the nine-year period. This is reflected by the different levels of cumulative T/M/S experience among the squadron types. Figure 38 shows the comparison across the aviation communities.

Figure 38. Change in Navy squadron average maintainer career time with T/M/S, FY 2004 to FY 2012 by squadron type



It is clear that even with the overall increase in career experience results, introduction of new aircraft and changes in T/M/S aircraft can cause a significant initial loss in T/M/S experience such as currently being experienced in the maritime strike (HSM) helicopter squadrons.

NATEC RFA hours

As part of the analysis, we wanted to examine the amount of technical support provided to the squadrons by NATEC. The submitted field requests are organized and broken up into requests for assistance (RFA), requests for information (RFT) and requests for training (RFT). We were only able to capture complete data for FY 2009 to FY 2012. We first looked at how many annual technical support hours were provided to the squadrons in support of RFAs. Figure 39 shows the results.

Figure 39. Navy squadron total NATEC RFA support hours, FY 2009 to FY 2012

Total Navy O-Level NATEC RFA support hours														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2009	926.5	3,262.8	2,160.3	2,970.2	1,969.9	1,071.5	48.7	280.0	2,533.5	1,213.7	164.0	782.6	77.1	17,460.8
2010	2,001.8	2,758.0	3,234.7	870.7	2,852.5	2,133.2	9.0	484.3	3,909.2	692.0	235.0	363.3	497.7	20,041.3
2011	1,804.1	3,658.6	1,671.4	2,259.9	985.2	0.0	0.0	1,652.9	2,937.3	1,692.0	776.2	227.9	1,309.0	18,974.4
2012	1,358.2	2,309.8	2,954.7	1,255.9	2,592.2	3,352.6	20.4	2.0	2,456.6	1,185.5	744.6	71.3	983.0	19,286.7
Change	46.6%	-29.2%	36.8%	-57.7%	31.6%	212.9%	-58.1%	-99.3%	-3.0%	-2.3%	354.0%	-90.9%	1175.0%	10.5%
	431.7	-953.0	794.4	-1,714.4	622.3	2,281.1	-28.3	-278.0	-76.9	-28.2	580.6	-711.3	905.9	1,826.0

Table 20 provides a summary of the total column from figure 39.

Table 20. Navy squadron annual NATEC RFA support hours, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
20,041	18,941	17,461	10.5%	1,826	1,084	0.06

The total annual technical support for RFAs increased—by 10.5 percent or 11,826 hours.

NATEC RFI hours

We examined the annual technical support hours provided for RFIs. Figure 40 shows the results.

Figure 40. Navy squadron total NATEC RFI support hours, FY 2009 to FY 2012

Total Navy O-Level NATEC RFI support hours														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2009	36.9	288.2	323.5	97.4	214.1	213.0	0.0	1.5	310.2	69.0	20.0	16.5	0.0	1,590.3
2010	55.8	339.1	359.9	83.0	541.0	82.5	0.0	55.8	202.4	5.5	4.0	10.0	23.0	1,762.0
2011	74.5	226.7	501.5	60.5	121.8	0.0	1.0	544.7	335.8	84.8	69.5	28.0	66.5	2,115.3
2012	76.5	220.2	412.8	170.5	1,097.2	217.5	0.0	0.0	370.8	0.0	40.3	2.0	54.0	2,661.8
Change	107.3%	-23.6%	27.6%	75.1%	412.5%	2.1%	#DIV/0!	-100.0%	19.5%	-100.0%	101.5%	-87.9%	#DIV/0!	67.4%
	39.6	-68.0	89.3	73.1	883.1	4.5	0.0	-1.5	60.6	-69.0	20.3	-14.5	54.0	1,071.6

Table 21 provides a summary of the total column from figure 40.

Table 21. Navy squadron annual NATEC RFI support hours, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
2,662	2,032	1,590	67.4%	1,072	473	0.23

The total annual technical support for RFIs increased—by 67.4 percent or 1,072 hours The CV is high because the rapid increase in RFI support caused significant variation in the annual results and the period of analysis is only four years.

NATEC RFT hours

We also examined the annual technical support hours provided for RFTs. Figure 41 shows the results.

Figure 41. Navy squadron total NATEC RFT support hours, FY 2009 to FY 2012

Total Navy O-Level NATEC RFT support hours														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2009	266.0	368.0	1,409.5	1,510.7	1,476.6	59.0	0.0	1,572.0	1,323.5	413.5	135.5	118.9	32.0	8,685.2
2010	363.7	940.0	1,562.5	464.0	2,631.4	354.5	0.0	1,704.0	286.0	0.0	20.9	28.0	119.0	8,474.0
2011	668.5	1,115.1	1,083.8	712.0	661.6	53.5	0.0	963.0	218.8	442.5	186.0	31.0	215.5	6,351.3
2012	275.3	336.2	860.8	652.0	2,763.5	290.5	144.0	0.0	659.3	251.5	163.2	8.5	494.5	6,899.3
Change	3.5%	-8.6%	-38.9%	-56.8%	87.2%	392.4%	#DIV/0!	-100.0%	-50.2%	-39.2%	20.4%	-92.9%	1445.3%	-20.6%
	9.3	-31.8	-548.7	-858.7	1,286.9	231.5	144.0	-1,572.0	-664.2	-162.0	27.7	-110.4	462.5	-1,785.9

Table 22 provides a summary of the total column from figure 41.

Table 22. Navy squadron annual NATEC RFT support hours, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
8,685	7,602	6,351	-20.6%	-1,786	1,154	0.15

The total annual technical support for RFTs decreased—by -20.6 percent or 1,786 hours The CV is also high because the rapid decrease in RFT support caused significant variation in the annual results and the period of analysis is only four years. This decline in training requests is not a welcome trend as training prior to deployment is the most effective use of the NATEC resources. Squadrons should be encouraged to request maintenance training during deployment workups.

NATEC total support hours

Finally, we consolidated the support requests to get an annual total support number. Figure 42 shows the results.

Figure 42. Navy squadron total annual NATEC support hours, FY 2009 to FY 2012

Total Navy O-Level NATEC support hours														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2009	1,229.4	3,918.9	3,893.3	4,578.3	3,660.6	1,343.5	48.7	1,853.5	4,167.2	1,696.2	319.5	918.0	109.1	27,736.2
2010	2,421.3	4,037.0	5,157.1	1,417.7	6,024.9	2,570.2	9.0	2,244.1	4,397.6	697.5	259.9	401.3	639.7	30,277.3
2011	2,547.1	5,000.4	3,256.7	3,032.4	1,768.6	53.5	1.0	3,160.6	3,491.9	2,219.3	1,031.7	286.9	1,591.0	27,441.0
2012	1,710.0	2,866.2	4,228.3	2,078.4	6,452.9	3,860.6	164.4	2.0	3,486.7	1,437.0	948.1	81.8	1,531.5	28,847.8
Change	39.1%	-26.9%	8.6%	-54.6%	76.3%	187.4%	237.6%	-99.9%	-16.3%	-15.3%	196.7%	-91.1%	1303.8%	4.0%
	480.6	-1,052.8	335.0	-2,500.0	2,792.3	2,517.1	115.7	-1,851.5	-680.5	-259.2	628.6	-836.2	1,422.4	1,111.6

Table 23 provides a summary of the total column from figure 42.

Table 23. Navy squadron annual NATEC support hours, total number analysis

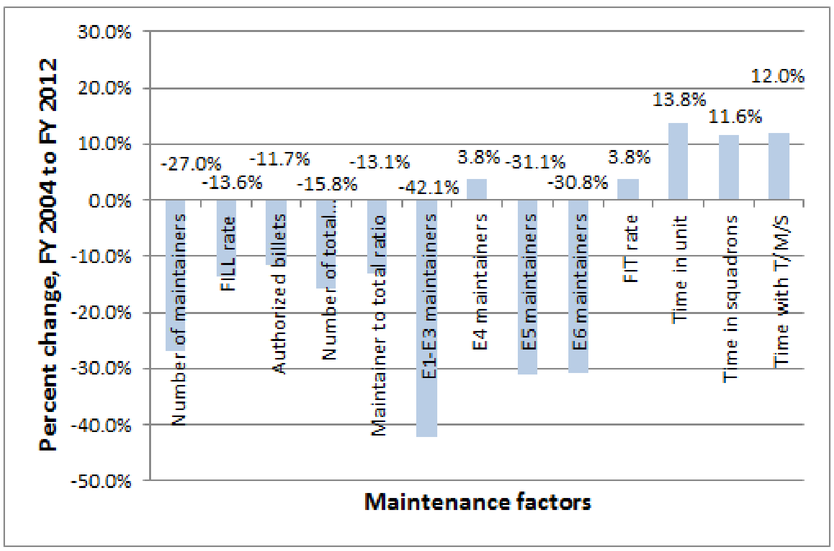
Maximum	Mean	Minimum	% change	Value change	SD	CV
30,277	28,576	27,441	4.0%	1,112	1,286	0.05

The total annual NATEC support hours provided to squadrons increased—by 4.0 percent or 1,112 hours. However, the trends of increasing RFA and FRI support partally at the expense of reduced RFT support should be watched closely.

Summary of changes

Figure 43 provides a comparison of the percent of change for each of the factors from FY 2004 to FY 2012.

Figure 43. Navy maintenance factors percent change factor summary, FY 2004 to FY 2012



Figures 44 and 45 provides the same information but on timelines that shows the index change each year when compared to the baseline year of FY 2004.

Figure 44. Navy maintenance factors index change timeline, FY 2004 to FY 2012

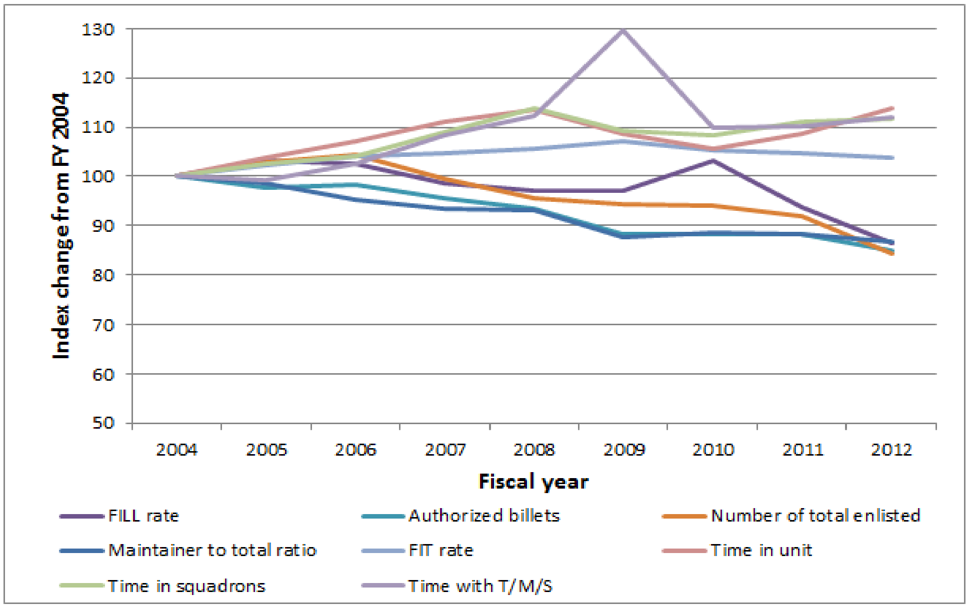
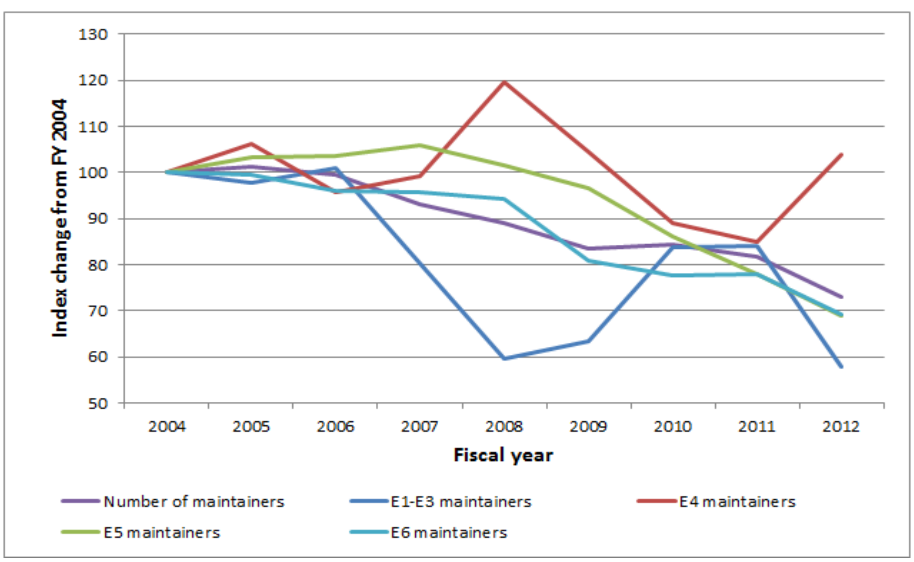


Figure 45. Navy maintenance factors maintainer index change timeline, FY 2004 to FY 2012



We did not include the NATEC support hours in figure 43, because we only had complete information for four years. Figure 46 shows the NATEC percent change summary.

Figure 46. NATEC annual support hours percent change factor summary, FY 2009 to FY 2012

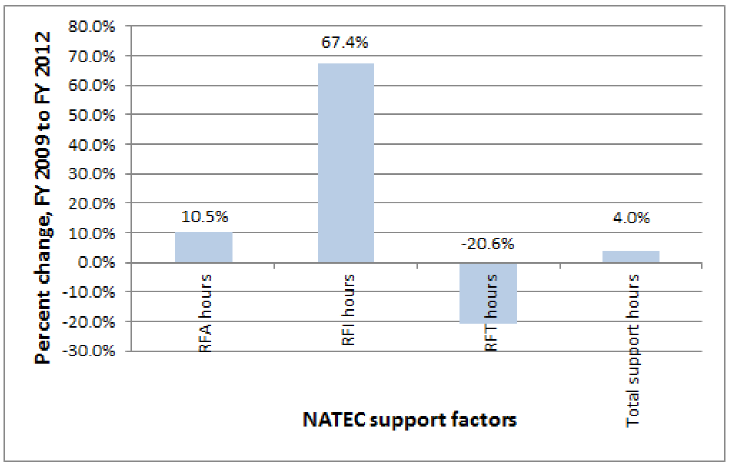
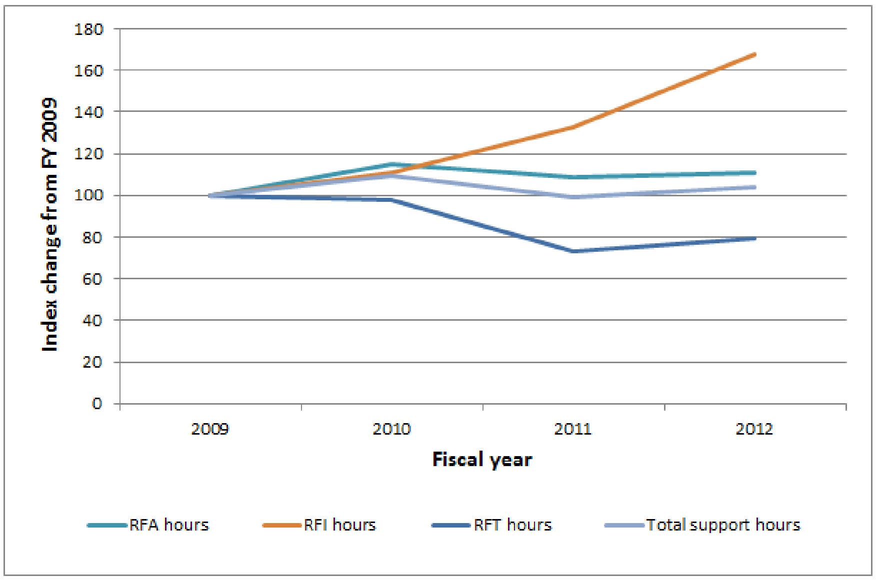


Figure 47 provides the same information but on timelines that shows the index change each year when compared to the baseline year of FY 2009.

Figure 47. NATEC annual support hours index change timeline, FY 2009 to FY 2012



Maintenance outcome measures

As table 2 shows, 10 fields capture the maintenance outcome measures of the different aviation squadrons. We looked at 8 of the fields to determine the extent of operational change over the nine years. We did not examine the annual NMCM hours or PMCM hours as we used these as data check points to ensure the primary NMCM and primary PMCN did not exceed the totals.

Annual AFM cost

We first looked at the aviation fleet maintenance (AFM) obligations for the individual squadrons. We could not isolate individual squadron costs from the standard Navy financial reports. In order to capture the individual squadron obligations, we had to back into the costs through calculation by using the OP-20 report flying hour unit costs by T/M/S and multiplying that by the total flying hours logged by that squadron for that T/M/S aircraft during that fiscal year. This provided us with a close approximation of the total obligations for each squadron.

Figure 48 shows the changes in AFM costs in constant FY 2012 dollars over the period.

Figure 48. Navy squadron annual AFM costs, FY 2004 to FY 2012

Total annual AFM cost (FM)

FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	$260,415,820	$64,124,746	$45,495,593	$17,633,588	$30,563,599	$8,960,975	$7,622,177	$4,114,350	$46,211,300	$30,271,513	$19,940,312	$22,357,338	$12,671,823	$570,383,134
2005	$229,255,394	$49,428,441	$42,192,756	$16,066,311	$32,202,641	$9,916,463	$11,328,523	$3,968,043	$29,580,092	$26,552,690	$17,862,955	$14,342,168	$14,597,679	$497,294,155
2006	$246,479,871	$44,775,200	$52,171,899	$16,096,912	$29,207,197	$8,887,929	$6,460,681	$4,281,767	$24,713,637	$29,890,170	$19,061,325	$12,209,460	$10,902,140	$505,138,188
2007	$210,128,322	$55,166,735	$49,879,851	$17,761,254	$28,415,393	$7,368,427	$7,480,299	$5,026,846	$25,984,581	$34,040,494	$19,728,036	$15,810,945	$12,305,498	$489,096,682
2008	$256,684,502	$33,228,072	$52,042,513	$19,495,241	$25,830,053	$4,779,321	$6,410,069	$7,253,315	$31,548,157	$28,216,009	$19,734,961	$16,272,196	$21,552,411	$523,046,820
2009	$234,325,380	$57,377,706	$46,946,375	$23,146,399	$28,276,677	$4,432,830	$8,569,313	$9,015,333	$54,803,891	$36,275,802	$25,136,584	$14,467,192	$12,802,252	$555,575,734
2010	$241,625,902	$58,770,741	$48,721,259	$21,536,763	$25,968,699	$6,258,717	$9,529,174	$6,097,282	$43,162,525	$29,133,356	$18,366,208	$17,509,771	$39,731,147	$566,411,545
2011	$199,889,777	$76,407,925	$48,386,862	$18,498,534	$32,807,045	$8,827,284	$10,246,633	$7,198,029	$51,665,487	$32,985,715	$20,704,009	$20,554,513	$63,273,774	$591,445,586
2012	$270,836,641	$62,604,034	$47,370,795	$20,388,167	$30,251,011	$8,292,803	$9,409,069	$6,086,289	$53,973,992	$23,689,105	$20,567,471	$16,595,959	$25,990,468	$596,055,804
Change	4.0%	-2.4%	4.1%	15.6%	-1.0%	-7.5%	23.4%	47.9%	16.8%	-21.7%	3.1%	-25.8%	105.1%	4.5%
	$10,420,821	-$1,520,712	$1,875,202	$2,754,579	-$312,588	-$668,172	$1,786,892	$1,971,939	$7,762,692	-$6,582,408	$627,159	-$5,761,379	$13,318,645	$25,672,670

Table 24 provides a summary of the total column from figure 48.

Table 24. Navy squadron annual AFM costs, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
$596,056K	$543,828K	$489,097K	4.5%	$25,673K	$40,985K	0.08

The total annual AFM costs increased in real terms by 4.5 percent or $25.673 million. Figures 49 and 50 provide the same breakdowns, but segmented into fixed-wing and rotary squadron totals.

Both aviation classes of squadrons had real increases in AFM costs; however, the AFM in the rotary squadrons increased at a higher rate. AFM costs for the rotary squadrons increased by $9.365 million (7.1 percent) while for fixed-wing squadrons, AFM costs increased by $16.308 million (3.7 percent).

Figure 49. Total annual constant dollars, fixed-wing AFM costs

Total annual fixed-wing AFM cost (FM)									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	$30,563,599	$45,495,593	$7,622,177	$17,633,588	$64,124,746	$8,960,975	$4,114,350	$260,415,820	$438,930,848
2005	$32,202,641	$42,192,756	$11,328,523	$16,066,311	$49,428,441	$9,916,463	$3,968,043	$229,255,394	$394,358,572
2006	$29,207,197	$52,171,899	$6,460,681	$16,096,912	$44,775,200	$8,887,929	$4,281,767	$246,479,871	$408,361,457
2007	$28,415,393	$49,879,851	$7,480,299	$17,761,254	$55,166,735	$7,368,427	$5,026,846	$210,128,322	$381,227,127
2008	$25,830,053	$52,042,513	$6,410,069	$19,495,241	$33,228,072	$4,779,321	$7,253,315	$256,684,502	$405,723,086
2009	$28,276,677	$46,946,375	$8,569,313	$23,146,399	$57,377,706	$4,432,830	$9,015,333	$234,325,380	$412,090,013
2010	$25,968,699	$48,721,259	$9,529,174	$21,536,763	$58,770,741	$6,258,717	$6,097,282	$241,625,902	$418,508,537
2011	$32,807,045	$48,386,862	$10,246,633	$18,498,534	$76,407,925	$8,827,284	$7,198,029	$199,889,777	$402,262,089
2012	$30,251,011	$47,370,795	$9,409,069	$20,388,167	$62,604,034	$8,292,803	$6,086,289	$270,836,641	$455,238,809
Change	-1.0%	4.1%	23.4%	15.6%	-2.4%	-7.5%	47.9%	4.0%	3.7%
	-$312,588	$1,875,202	$1,786,892	$2,754,579	-$1,520,712	-$668,172	$1,971,939	$10,420,821	$16,307,961

Figure 50. Total annual constant dollars, rotary AFM costs

Total annual rotary AFM cost (FM)						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	$22,357,338	$30,271,513	$19,940,312	$12,671,823	$46,211,300	$131,452,286
2005	$14,342,168	$26,552,690	$17,862,955	$14,597,679	$29,580,092	$102,935,583
2006	$12,209,460	$29,890,170	$19,061,325	$10,902,140	$24,713,637	$96,776,732
2007	$15,810,945	$34,040,494	$19,728,036	$12,305,498	$25,984,581	$107,869,555
2008	$16,272,196	$28,216,009	$19,734,961	$21,552,411	$31,548,157	$117,323,734
2009	$14,467,192	$36,275,802	$25,136,584	$12,802,252	$54,803,891	$143,485,721
2010	$17,509,771	$29,133,356	$18,366,208	$39,731,147	$43,162,525	$147,903,008
2011	$20,554,513	$32,985,715	$20,704,009	$63,273,774	$51,665,487	$189,183,497
2012	$16,595,959	$23,689,105	$20,567,471	$25,990,468	$53,973,992	$140,816,995
Change	-25.8%	-21.7%	3.1%	105.1%	16.8%	7.1%
	-$5,761,379	-$6,582,408	$627,159	$13,318,645	$7,762,692	$9,364,709

Annual AVDLR cost

We also identified the annual obligations to purchase high cost aviation depot repairable parts (AVDLR). Figure 51 shows the changes in AVDLR costs in constant FY 2012 dollars over the period.

Figure 51. Navy squadron annual AVDLR costs, FY 2004 to FY 2012

Total annual AVDLR cost (FA)														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	$636,826,796	$124,934,862	$81,920,740	$26,465,088	$79,250,340	$17,830,555	$7,318,479	$8,720,262	$84,354,595	$87,432,907	$60,700,499	$59,667,972	$32,745,698	$1,308,168,792
2005	$511,816,608	$113,641,762	$82,959,226	$21,749,079	$70,339,206	$20,788,906	$14,510,223	$8,038,264	$66,208,167	$96,035,019	$58,362,085	$37,125,025	$45,770,626	$1,147,344,196
2006	$554,817,911	$117,138,636	$96,340,105	$25,546,235	$64,652,444	$14,535,564	$14,938,585	$9,771,540	$63,788,457	$90,023,917	$55,525,874	$48,206,193	$33,898,879	$1,189,184,341
2007	$524,816,293	$127,656,188	$102,380,635	$24,207,059	$72,172,880	$10,209,280	$22,669,894	$10,782,548	$64,803,231	$102,279,051	$61,737,771	$49,459,039	$46,901,406	$1,220,075,273
2008	$532,334,150	$80,280,450	$111,004,214	$27,398,275	$54,001,905	$2,514,461	$14,076,128	$15,453,778	$69,309,254	$83,466,273	$57,318,116	$40,538,549	$51,727,145	$1,139,422,700
2009	$530,078,828	$124,034,203	$100,379,435	$40,425,197	$51,666,990	$2,564,193	$14,973,286	$19,035,590	$129,139,750	$95,553,800	$70,340,564	$34,120,222	$51,128,940	$1,263,440,999
2010	$530,606,718	$138,194,861	$89,638,797	$21,822,712	$51,972,688	$10,499,803	$17,635,667	$13,236,503	$122,128,418	$94,161,781	$65,496,423	$42,990,194	$49,364,778	$1,247,749,344
2011	$456,312,883	$165,229,427	$101,278,464	$20,596,839	$55,447,358	$15,627,146	$19,374,926	$15,263,055	$140,058,926	$108,562,323	$97,792,487	$43,642,668	$58,600,917	$1,297,787,419
2012	$476,009,797	$135,957,220	$88,312,934	$14,146,270	$57,264,564	$16,274,653	$12,560,333	$13,531,436	$166,890,542	$67,404,388	$110,789,079	$42,010,228	$54,028,522	$1,255,179,966
Change	-25.3%	8.8%	7.8%	-46.5%	-27.7%	-8.7%	71.6%	55.2%	97.8%	-22.9%	82.5%	-29.6%	65.0%	-4.1%
	-$160,817,000	$11,022,358	$6,392,194	-$12,318,818	-$21,985,776	-$1,555,902	$5,241,854	$4,811,174	$82,535,947	-$20,028,519	$50,088,580	-$17,657,744	$21,282,824	-$52,988,826

Table 25 provides a summary of the total column from figure 51.

Table 25. Navy squadron annual AVDLR costs, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
$1,308,169K	$1,229,817K	$1,139,423K	-4.1%	-$52,989K	$60,800K	0.05

The total annual AVDLR costs decreased in real terms by 4.1 percent or $52.989 million. Figures 52 and 53 provide the same breakdowns, but segmented into fixed-wing and rotary squadron totals.

Figure 52. Total annual constant dollars, fixed-wing AVDLR costs

Total annual fixed-wing AVDLR cost (FA)									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	$79,250,340	$81,920,740	$7,318,479	$26,465,088	$124,934,862	$17,830,555	$8,720,262	$636,826,796	$983,267,122
2005	$70,339,206	$82,959,226	$14,510,223	$21,749,079	$113,641,762	$20,788,906	$8,038,264	$511,816,608	$843,843,274
2006	$64,652,444	$96,340,105	$14,938,585	$25,546,235	$117,138,636	$14,535,564	$9,771,540	$554,817,911	$897,741,020
2007	$72,172,880	$102,380,635	$22,669,894	$24,207,059	$127,656,188	$10,209,280	$10,782,548	$524,816,293	$894,894,776
2008	$54,001,905	$111,004,214	$14,076,128	$27,398,275	$80,280,450	$2,514,461	$15,453,778	$532,334,150	$837,063,363
2009	$51,666,990	$100,379,435	$14,973,286	$40,425,197	$124,034,203	$2,564,193	$19,035,590	$530,078,828	$883,157,723
2010	$51,972,688	$89,638,797	$17,635,667	$21,822,712	$138,194,861	$10,499,803	$13,236,503	$530,606,718	$873,607,749
2011	$55,447,358	$101,278,464	$19,374,926	$20,596,839	$165,229,427	$15,627,146	$15,263,055	$456,312,883	$849,130,099
2012	$57,264,564	$88,312,934	$12,560,333	$14,146,270	$135,957,220	$16,274,653	$13,531,436	$476,009,797	$814,057,207
Change	-27.7%	7.8%	71.6%	-46.5%	8.8%	-8.7%	55.2%	-25.3%	-17.2%
	-$21,985,776	$6,392,194	$5,241,854	-$12,318,818	$11,022,358	-$1,555,902	$4,811,174	-$160,817,000	-$169,209,915

Figure 53. Total annual constant dollars, rotary AVDLR costs

Total annual rotary AVDLR cost (FA)						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	$59,667,972	$87,432,907	$60,700,499	$32,745,698	$84,354,595	$324,901,670
2005	$37,125,025	$96,035,019	$58,362,085	$45,770,626	$66,208,167	$303,500,922
2006	$48,206,193	$90,023,917	$55,525,874	$33,898,879	$63,788,457	$291,443,321
2007	$49,459,039	$102,279,051	$61,737,771	$46,901,406	$64,803,231	$325,180,497
2008	$40,538,549	$83,466,273	$57,318,116	$51,727,145	$69,309,254	$302,359,337
2009	$34,120,222	$95,553,800	$70,340,564	$51,128,940	$129,139,750	$380,283,276
2010	$42,990,194	$94,161,781	$65,496,423	$49,364,778	$122,128,418	$374,141,594
2011	$43,642,668	$108,562,323	$97,792,487	$58,600,917	$140,058,926	$448,657,320
2012	$42,010,228	$67,404,388	$110,789,079	$54,028,522	$166,890,542	$441,122,759
Change	-29.6%	-22.9%	82.5%	65.0%	97.8%	35.8%
	-$17,657,744	-$20,028,519	$50,088,580	$21,282,824	$82,535,947	$116,221,089

Annual AVDLR costs for fixed-wing squadrons declined by $169.210 million (17.2 percent); however, for the rotary squadrons annual costs increased by $116.221 million (35.8 percent), which offset much of the savings gained by the fixed-wing squadrons. These opposite trends should be investigated further to identify the drivers for each and share best practices.

Annual contract maintenance cost

We also looked at the annual obligations to purchase aviation fleet maintenance contract support. Figure 54 shows the changes in O-level contract maintenance costs in constant FY 2012 dollars over the period. These costs are allocated back to the squadrons although little, if any, of the actual work is performed on the flight line.

Figure 54. Navy squadron annual contract maintenance costs, FY 2004 to FY 2012

Total annual contract maintenance cost (FW)

FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	$16,998,232	$2,759,310	$10,114	$47,560,200	$6,237,963	$0	$11,949,122	$242,115	$908,072	$0	$2,036,797	$0	$0	$88,701,924
2005	$15,359,055	$2,238,521	$494,353	$42,750,433	$17,494,293	$57,964	$20,710,946	$256,616	$3,255,035	$0	$1,368,076	$0	$0	$103,985,292
2006	$11,291,663	$617,141	$971,796	$39,419,811	$7,008,101	$15,704	$17,048,576	$225,328	$7,503,626	$144,228	$2,014,652	$83,918	$0	$86,344,544
2007	$27,258,137	$4,203,834	$2,617,614	$51,389,493	$12,249,855	$286,410	$23,609,610	$463,245	$13,324,107	$0	$2,654,966	$1,645,864	$0	$139,703,136
2008	$9,838,803	$2,996,966	$1,667,594	$48,854,776	$8,982,862	$51,704	$22,997,829	$351,569	$18,892,837	$0	$1,911,612	$18,341	$5,093,361	$121,658,256
2009	$41,159,637	$5,986,651	$22,601,351	$51,554,846	$10,300,102	$52,483	$38,754,680	$635,908	$3,826,730	$3,246	$4,956,399	$2,026,630	$15,304,587	$197,163,248
2010	$44,118,759	$5,205,998	$17,403,318	$53,469,955	$9,525,135	$23,691	$30,763,521	$398,033	$5,084,996	$2,985	$3,490,997	$2,849,947	$1,784,227	$174,121,563
2011	$12,870,382	$8,345,994	$25,129,586	$37,538,432	$10,840,703	$118,265	$31,914,804	$588,821	$8,339,914	$2,923	$9,652,049	$2,132,617	$295,722	$147,770,211
2012	$17,214,101	$11,327,934	$23,422,291	$37,521,907	$10,139,883	$131,868	$27,815,058	$122,265	$9,563,776	$1,980	$84,088	$2,374,625	$115,072	$139,834,848
Change	1.3%	310.5%	231482.7%	-21.1%	62.6%	#DIV/0!	132.8%	-49.5%	953.2%	#DIV/0!	-95.9%	#DIV/0!	#DIV/0!	57.6%
	$215,869	$8,568,624	$23,412,177	-$10,038,293	$3,901,920	$131,868	$15,865,936	-$119,850	$8,655,704	$1,980	-$1,952,709	$2,374,625	$115,072	$51,132,924

Table 26 provides a summary of the total column from figure 54.

Table 26. Navy squadron annual contract maintenance costs, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
$197,163K	$133,254K	$86,345K	57.6%	$51,133K	$37,461K	0.28

The total annual allocated contract maintenance costs increased in real terms by 57.6 percent or $51.133 million and there was some variation from year to year. Figures 55 and 56 provide the same breakdowns, but segmented into fixed-wing and rotary squadron totals.

Figure 55. Total annual constant dollars, fixed-wing contract maintenance costs

Total annual fixed-wing contract maintenance cost (FW)									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	$6,237,963	$10,114	$11,949,122	$47,560,200	$2,759,310	$0	$242,115	$16,998,232	$85,757,056
2005	$17,494,293	$494,353	$20,710,946	$42,750,433	$2,238,521	$57,964	$256,616	$15,359,055	$99,362,180
2006	$7,008,101	$971,796	$17,048,576	$39,419,811	$617,141	$15,704	$225,328	$11,291,663	$76,598,121
2007	$12,249,855	$2,617,614	$23,609,610	$51,389,493	$4,203,834	$286,410	$463,245	$27,258,137	$122,078,199
2008	$8,982,862	$1,667,594	$22,997,829	$48,854,776	$2,996,966	$51,704	$351,569	$9,838,803	$95,742,105
2009	$10,300,102	$22,601,351	$38,754,680	$51,554,846	$5,986,651	$52,483	$635,908	$41,159,637	$171,045,657
2010	$9,525,135	$17,403,318	$30,763,521	$53,469,955	$5,205,998	$23,691	$398,033	$44,118,759	$160,908,411
2011	$10,840,703	$25,129,586	$31,914,804	$37,538,432	$8,345,994	$118,265	$588,821	$12,870,382	$127,346,986
2012	$10,139,883	$23,422,291	$27,815,058	$37,521,907	$11,327,934	$131,868	$122,265	$17,214,101	$127,695,307
Change	62.6%	231482.7%	132.8%	-21.1%	310.5%	#DIV/0!	-49.5%	1.3%	48.9%
	$3,901,920	$23,412,177	$15,865,936	-$10,038,293	$8,568,624	$131,868	-$119,850	$215,869	$41,938,252

Figure 56. Total annual constant dollars, rotary contract maintenance costs

Total annual rotary contract maintenance cost (FW)						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	$0	$0	$2,036,797	$0	$908,072	$2,944,868
2005	$0	$0	$1,368,076	$0	$3,255,035	$4,623,112
2006	$83,918	$144,228	$2,014,652	$0	$7,503,626	$9,746,423
2007	$1,645,864	$0	$2,654,966	$0	$13,324,107	$17,624,937
2008	$18,341	$0	$1,911,612	$5,093,361	$18,892,837	$25,916,151
2009	$2,026,630	$3,246	$4,956,399	$15,304,587	$3,826,730	$26,117,592
2010	$2,849,947	$2,985	$3,490,997	$1,784,227	$5,084,996	$13,213,152
2011	$2,132,617	$2,923	$9,652,049	$295,722	$8,339,914	$20,423,224
2012	$2,374,625	$1,980	$84,088	$115,072	$9,563,776	$12,139,541
Change	#DIV/0!	#DIV/0!	-95.9%	#DIV/0!	953.2%	312.2%
	$2,374,625	$1,980	-$1,952,709	$115,072	$8,655,704	$9,194,673

The allocations to both classes of squadrons increased but at different rates. The fixed-wing squadrons experienced an increase in annual contract maintenance costs of $41.938 million (48.9 percent), whereas the rotary squadrons experienced a smaller dollar cost increase of $9.195 million (312.2 percent).

Total annual O-level squadron maintenance costs

We consolidated these annual costs to look at the total annual maintenance obligations. Figure 57 shows the changes in total O-level maintenance costs in constant FY 2012 dollars over the period.

Table 27 provides a summary of the total column from figure 57.

The total obligations increased by only 1.2 percent however that generats an additional $24 million in cost. The reduction in AVDLR costs seem to be related to the increase in contract support costs since the

Figure 57. Total annual O-level squadron maintenance costs, FY 2004 to FY 2012

Total annual maintenance cost														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	$914,240,849	$191,818,918	$127,426,447	$91,658,876	$116,051,902	$26,791,530	$26,889,778	$13,076,726	$131,473,968	$117,704,420	$82,677,607	$82,025,309	$45,417,521	$1,967,253,850
2005	$756,431,057	$165,308,723	$125,646,334	$80,565,823	$120,036,140	$30,763,333	$46,549,692	$12,262,923	$99,043,294	$122,587,709	$77,593,116	$51,467,192	$60,368,305	$1,748,623,643
2006	$812,589,445	$162,530,977	$149,483,800	$81,062,959	$100,867,742	$23,439,198	$38,447,842	$14,278,635	$96,005,720	$120,058,314	$76,601,851	$60,499,571	$44,801,019	$1,780,667,073
2007	$762,202,752	$187,026,757	$154,878,101	$93,357,806	$112,838,128	$17,864,116	$53,759,803	$16,272,640	$104,111,919	$136,319,545	$84,120,773	$66,915,848	$59,206,904	$1,848,875,091
2008	$798,857,455	$116,505,489	$164,714,322	$95,748,293	$88,814,821	$7,345,486	$43,484,027	$23,058,662	$119,750,248	$111,682,282	$78,964,688	$56,829,087	$78,372,917	$1,784,127,776
2009	$805,563,845	$187,398,560	$169,927,161	$115,126,441	$90,243,769	$7,049,505	$62,297,279	$28,686,832	$187,770,371	$131,832,848	$100,433,547	$50,614,043	$79,235,779	$2,016,179,981
2010	$816,351,379	$202,171,600	$155,763,374	$96,829,430	$87,466,522	$16,782,212	$57,928,363	$19,731,818	$170,375,939	$123,298,122	$87,353,629	$63,349,912	$90,880,152	$1,988,282,452
2011	$669,073,042	$249,983,345	$174,794,912	$76,633,806	$99,095,106	$24,572,694	$61,536,363	$23,049,906	$200,064,327	$141,550,961	$128,148,544	$66,329,797	$122,170,413	$2,037,003,215
2012	$764,060,539	$209,889,188	$159,106,020	$72,056,344	$97,655,458	$24,699,324	$49,784,460	$19,739,990	$230,428,310	$91,095,473	$131,440,638	$60,980,812	$80,134,062	$1,991,070,618
Change	-16.4%	9.4%	24.9%	-21.4%	-15.9%	-7.8%	85.1%	51.0%	75.3%	-22.6%	59.0%	-25.7%	76.4%	1.2%
	-$150,180,310	$18,070,270	$31,679,573	-$19,602,532	-$18,396,444	-$2,092,206	$22,894,682	$6,663,264	$98,954,342	-$26,608,947	$48,763,031	-$21,044,497	$34,716,541	$23,816,767

Table 27. Navy squadron annual maintenance costs, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
$2,037,003K	$1,906,898K	$1,748,624K	1.2%	-$23,817K	$$114,916K	0.06

majority of the contract support is at the intermediate and depot levels. They roughly offset each other. The overall increase is mostly linked to the increase of fleet maintenance (FM) obligations. From figure 48 the bulk of the $25.7 million increase is being generated by the strike fighter (VFA) and mine countermeasures (HM) squadrons.

Average annual total maintenance cost per EIS hour

We summed the total annual squadron maintenance costs and divided them into the logged equipment in service (EIS) hours for each squadron to see the changes in unit costing. Figure 58 shows the changes in O-level maintenance costs per EIS hour in constant FY 2012 dollars over the period.

Table 28 provides a summary of the total column from figure 58.

The average squadron maintenance cost per EIS hour decreased by 8.7 percent or $20 per hour in real terms. Figures 59 and 60 provide the same breakdowns, but segmented into fixed-wing and rotary squadron totals.

Figure 58. Navy squadron average maintenance cost per EIS hour, FY 2004 to FY 2012

Average annual total maintenance cost per EIS hour														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	$207	$214	$323	$208	$325	$206	$96	$237	$251	$173	$187	$255	$249	$230
2005	$191	$249	$276	$183	$310	$236	$172	$221	$140	$153	$181	$136	$334	$203
2006	$222	$228	$316	$186	$308	$176	$113	$322	$166	$150	$191	$192	$266	$217
2007	$173	$251	$334	$223	$304	$175	$168	$376	$144	$190	$186	$201	$279	$210
2008	$174	$266	$285	$223	$246	$133	$109	$457	$133	$156	$153	$162	$346	$194
2009	$183	$384	$274	$254	$207	$189	$186	$704	$442	$179	$198	$128	$348	$257
2010	$188	$341	$220	$278	$231	$166	$155	$476	$144	$169	$174	$185	$471	$214
2011	$188	$356	$268	$224	$269	$208	$162	$559	$143	$196	$345	$194	$595	$234
2012	$217	$321	$214	$185	$271	$150	$129	$400	$153	$137	$142	$209	$426	$210
Change	4.6%	50.3%	-33.7%	-11.1%	-16.4%	-27.0%	34.2%	68.6%	-39.2%	-20.8%	-23.7%	-17.9%	71.2%	-8.7%
	$10	$108	-$109	-$23	-$53	-$56	$33	$163	-$99	-$36	-$44	-$46	$177	-$20

Table 28. Navy squadron average maintenance cost per EIS hour, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
$257	$219	$194	-8.7%	-$20	$19	0.09

Figure 59. Total annual constant dollars, fixed-wing maintenance cost per EIS hour

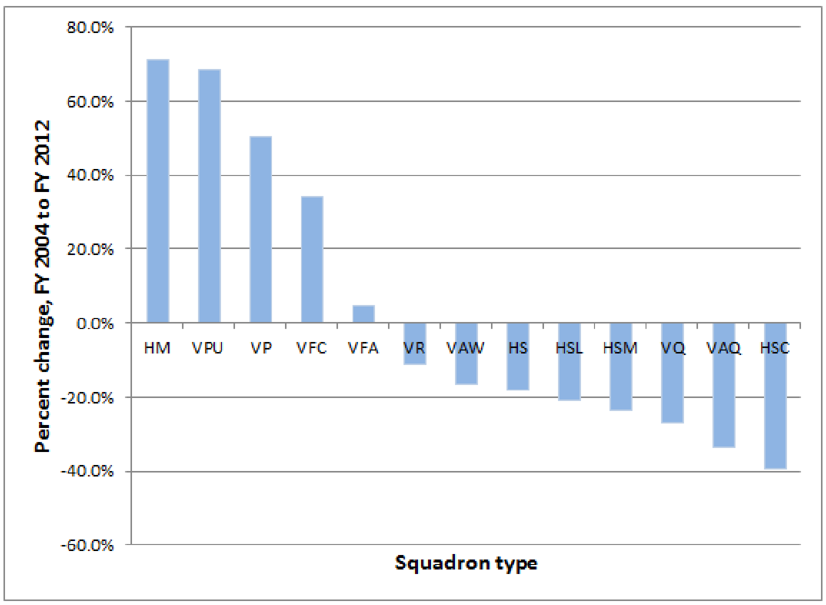
Average annual constant dollars fixed-wing maintenance cost per EIS hour									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	$325	$323	$96	$208	$214	$206	$237	$207	$230
2005	$310	$276	$172	$183	$249	$236	$221	$191	$222
2006	$308	$316	$113	$186	$228	$176	$322	$222	$234
2007	$304	$334	$168	$223	$251	$175	$376	$173	$225
2008	$246	$285	$109	$223	$266	$133	$457	$174	$212
2009	$207	$274	$186	$254	$384	$189	$704	$183	$243
2010	$231	$220	$155	$278	$341	$166	$476	$188	$230
2011	$269	$268	$162	$224	$356	$208	$559	$188	$241
2012	$271	$214	$129	$185	$321	$150	$400	$217	$228
Change	-16.4%	-33.7%	34.2%	-11.1%	50.3%	-27.0%	68.6%	4.6%	-0.7%
	-$53	-$109	$33	-$23	$108	-$56	$163	$10	-$2

Figure 60. Total annual constant dollars, rotary maintenance cost per EIS hour

Average annual constant dollars rotary maintenance cost per EIS hour						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	$255	$173	$187	$249	$251	$231
2005	$136	$153	$181	$334	$140	$155
2006	$192	$150	$191	$266	$166	$175
2007	$201	$190	$186	$279	$144	$174
2008	$162	$156	$153	$346	$133	$154
2009	$128	$179	$198	$348	$442	$292
2010	$185	$169	$174	$471	$144	$175
2011	$194	$196	$345	$595	$143	$218
2012	$209	$137	$142	$426	$153	$170
Change	-17.9%	-20.8%	-23.7%	71.2%	-39.2%	-26.6%
	-$46	-$36	-$44	$177	-$99	-$62

Even though the total annual squadron maintenance costs increased by 1.2 percent (see figure 57), the unit cost per EIS hour went down because of the increased number of aircraft in the inventory. EIS unit costs for fixed-wing squadrons fell by $2 or 0.7 percent, whereas, EIS costs for the rotary squadrons fell by $62 or 26.6 percent. However, the changes in unit cost for each squadron type varied greatly. Figure 61 shows this variation in cost per EIS hour by squadron type.

Figure 61. Navy squadron change in total maintenance unit cost per EIS hour in constant FY 2012 dollars



Even though the overall average unit cost decrease was $20 per EIS hour, some communities experienced cost growth. The mine countermeasures (HM) unit cost increased by $177/hour, special project (VPU) squadrons increased by $163/hour, patrol (VP) by $108/hour, fighter composite (VPU) by $33/hour, and strike fighter (VFA) by $10/hour. While additional financial data is necessary to see any relationship between unit cost growth or decline and share of contractor supported maintenance, the observed variation between squadrons would warrant additional analysis.

Annual logged maintenance man-hours

We next examined the total annual logged maintenance man-hours for each of the squadrons. Figure 62 provides the changes in squadron logged maintenance man-hours from FY 2004 to FY 2012.

Figure 62. Navy squadron logged maintenance man-hours, FY 2004 to FY 2012

Total annual logged maintenance hours														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	4,159,962	1,606,599	1,392,562	620,622	280,459	157,407	53,849	109,144	939,610	727,541	442,922	321,474	281,196	11,093,348
2005	3,507,724	1,081,913	1,500,044	668,511	427,268	110,429	62,199	95,362	914,763	816,207	482,329	297,709	297,806	10,262,264
2006	3,499,542	990,774	1,609,383	685,753	349,154	111,533	40,672	66,515	870,242	1,080,682	756,973	302,467	263,887	10,627,578
2007	3,737,292	805,177	1,625,982	663,459	345,797	74,821	50,091	74,227	886,637	1,332,202	755,638	359,399	334,166	11,044,888
2008	3,992,748	453,842	1,539,224	660,921	340,322	33,762	47,867	34,760	906,948	981,015	984,375	246,370	323,529	10,545,683
2009	3,752,341	443,728	1,039,555	626,146	375,588	2,900	64,031	32,450	724,980	537,162	560,427	259,412	313,062	8,731,783
2010	3,631,291	547,195	734,125	642,326	434,930	23,968	60,196	35,954	713,023	435,301	667,198	266,781	237,694	8,429,983
2011	2,201,675	689,592	716,061	540,580	467,128	38,139	40,943	33,282	778,140	420,002	745,886	272,754	162,345	7,106,527
2012	1,608,132	636,364	571,605	357,939	439,817	42,074	29,357	30,748	848,225	316,583	716,080	206,014	148,558	5,951,496
Change	**-61.3%**	**-60.4%**	**-59.0%**	**-42.3%**	**56.8%**	**-73.3%**	**-45.5%**	**-71.8%**	**-9.7%**	**-56.5%**	**61.7%**	**-35.9%**	**-47.2%**	**-46.4%**
	-2,551,830	**-970,234**	**-820,957**	**-262,683**	**159,358**	**-115,333**	**-24,493**	**-78,395**	**-91,385**	**-410,958**	**273,158**	**-115,460**	**-132,638**	**-5,141,852**

Table 29 provides a summary of the total column from figure 62.

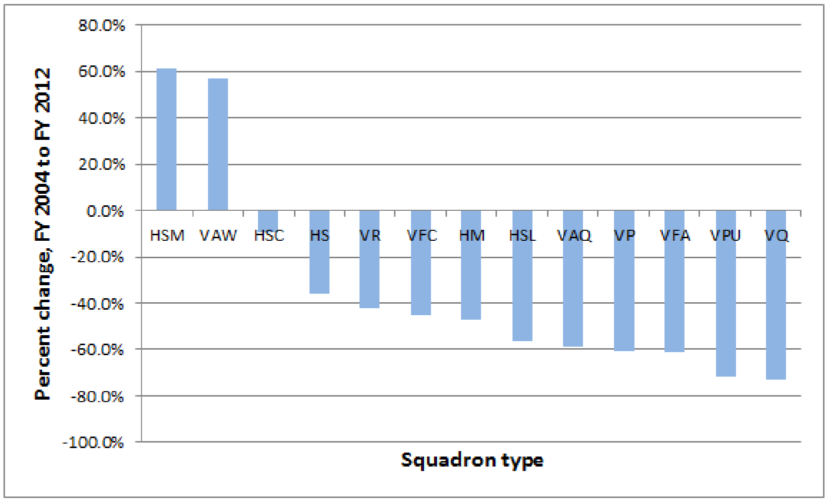
Table 29. Navy squadron logged maintenance man-hours, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
11,093,348	9,310,394	5,951,496	-46.4%	-5,141,852	1,857,535	0.20

The total squadron logged maintenance man-hours showed a steep decline of -46.4 percent or 5,141,852 hours despite an increase in the number of aircraft that needed to be maintained and the total number of flying hours flown. Figure 63 shows the distribution across the aviation communities.

Only the early warning (VAW), and maritime strike (HSM) squadrons experienced an increase in the number of annual man-hours. Figures

Figure 63. Change in Navy squadron logged maintenance man-hours, FY 2004 to FY 2012 by squadron type



64 and 65 provide the same breakdowns, but segmented into fixed-wing and rotary squadron totals.

Figure 64. Total fixed-wing annual logged maintenance hours

Total fixed-wing annual logged maintenance hours									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	280,459	1,392,562	53,849	620,622	1,606,599	157,407	109,144	4,159,962	8,380,604
2005	427,268	1,500,044	62,199	668,511	1,081,913	110,429	95,362	3,507,724	7,453,450
2006	349,154	1,609,383	40,672	685,753	990,774	111,533	66,515	3,499,542	7,353,327
2007	345,797	1,625,982	50,091	663,458	805,177	74,821	74,227	3,737,292	7,376,846
2008	340,322	1,539,224	47,867	660,921	453,842	33,762	34,760	3,992,748	7,103,446
2009	375,588	1,039,555	64,031	626,146	443,728	2,900	32,450	3,752,341	6,336,739
2010	434,930	734,125	60,196	642,326	547,195	23,968	35,954	3,631,291	6,109,985
2011	467,128	716,061	40,943	540,580	689,592	38,139	33,282	2,201,675	4,727,400
2012	439,817	571,605	29,357	357,939	636,364	42,074	30,748	1,608,132	3,716,037
Change	56.8%	-59.0%	-45.5%	-42.3%	-60.4%	-73.3%	-71.8%	-61.3%	-55.7%
	159,358	-820,957	-24,493	-262,683	-970,234	-115,333	-78,395	-2,551,830	-4,664,567

Annual logged maintenance hours for the fixed-wing squadrons dropped -55.7 percent or 4,664,567 hours. For rotary squadrons, annual logged maintenance hours only dropped by -17.6 percent or

Figure 65. Total rotary annual logged maintenance hours

Total rotary annual logged maintenance hours						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	321,474	727,541	442,922	281,196	939,610	2,712,743
2005	297,709	816,207	482,329	297,806	914,763	2,808,814
2006	302,467	1,080,682	756,973	263,887	870,242	3,274,251
2007	359,399	1,332,202	755,638	334,166	886,637	3,668,041
2008	246,370	981,015	984,375	323,529	906,948	3,442,237
2009	259,412	537,162	560,427	313,062	724,980	2,395,044
2010	266,781	435,301	667,198	237,694	713,023	2,319,998
2011	272,754	420,002	745,886	162,345	778,140	2,379,127
2012	206,014	316,583	716,080	148,558	848,225	2,235,459
Change	-35.9%	-56.5%	61.7%	-47.2%	-9.7%	-17.6%
	-115,460	-410,958	273,158	-132,638	-91,385	-477,284

477,284 hours. Some of both drops can be explained by the Naval Air Systems Command (NAVAIR) directed change in logged maintenance hour reporting policies. However, since there are significant differences between squadrons, something else must be influencing the change in maintenance hours. Since we saw such a steep reduction across most squadrons, we looked at the logged maintenance man-hours per maintainer to see how that had changed.

Maintenance man-hours per maintainer

Figure 66 provides changes in squadron logged maintenance man-hours per maintainer from FY 2004 to FY 2012.

Figure 66. Navy squadron logged maintenance man-hours per maintainer, FY 2004 to FY 2012

Average annual logged maintenance hours per maintainer													
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	AVERAGE
2004	567.7	507.3	604.5	499.5	259.7	570.3	494.0	463.4	468.7	625.2	594.9	456.3	377.3	519.1
2005	507.6	367.7	657.4	540.4	388.8	369.3	570.6	409.8	416.3	641.8	589.1	407.5	414.5	497.7
2006	515.1	341.6	767.6	526.6	332.0	417.7	359.9	285.9	390.3	843.7	915.3	442.7	413.9	521.7
2007	569.7	384.7	859.0	512.2	720.8	296.9	451.3	322.2	482.1	1,080.9	781.3	536.0	595.9	610.7
2008	651.0	337.4	839.7	518.7	593.0	150.7	427.4	146.0	522.1	781.8	1,017.2	380.9	571.8	607.1
2009	619.3	371.9	585.4	1,238.2	922.2	16.7	552.0	187.2	397.6	440.0	473.7	425.3	562.2	620.9
2010	581.0	264.0	408.3	615.8	911.4	138.5	573.3	204.2	381.5	355.6	533.2	453.7	424.0	504.9
2011	385.7	347.0	403.2	608.5	989.1	236.9	359.1	198.1	376.0	407.0	584.9	463.2	295.7	465.3
2012	301.5	337.0	334.3	544.2	1,075.0	205.2	269.3	203.6	423.6	533.8	630.7	531.9	290.9	446.7
Change	-46.9%	-33.6%	-44.7%	9.0%	313.9%	-64.0%	-45.5%	-56.1%	-9.6%	-14.6%	6.0%	16.5%	-22.9%	-14.0%
	-266.2	-170.3	-270.2	44.8	815.3	-365.1	-224.7	-259.8	-45.1	-91.5	35.8	75.5	-86.5	-72.4

Table 30 provides a summary of the average column from figure 66.

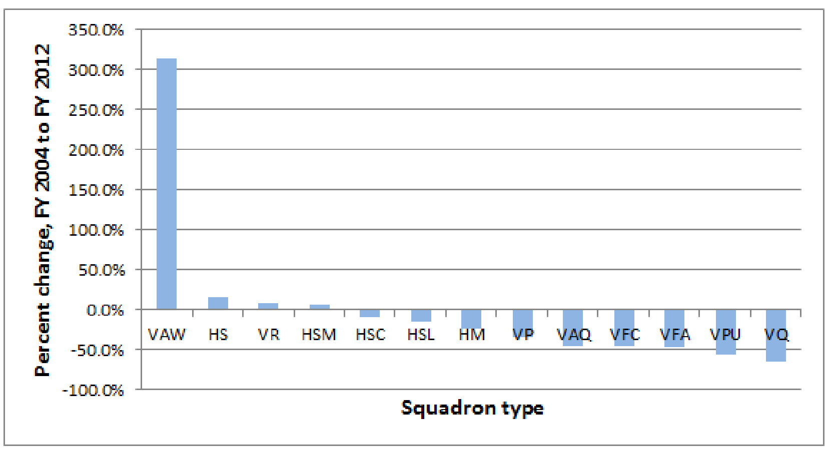
Table 30. Navy squadron logged maintenance man-hours per maintainer, average number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
620.9	532.7	446.7	-14.0%	-72.4	64.9	0.12

The unit measure of average squadron logged maintenance man-hours per maintainer declined by only -14.0 percent or 72.4 man-hours per maintainer which indicates that the majority of drop in logged maintenance hours was due to fewer maintainers rather than individual losses of productivity.

Figure 67 shows the distribution across the aviation communities.

Figure 67. Change in Navy squadron logged maintenance man-hours per maintainer, FY 2004 to FY 2012 by squadron type



The reduction in maintenance man-hours per maintainer was seen in all squadrons with the notable exceptions of the early warning (VAW), antisubmarine (HS), logistic support (VR), and maritime strike (HSM) communities. The large increase of 314 percent within the early warning (VAW) squadrons mask the more serious declines in strike fighter (VFA) man-hours (-46.9 percent), electronic attack (VAQ) man-hours (-44.7 percent), and patrol (VP) man-hours (-33.6 percent). The average logged maintenance hours per maintainer should have stayed relatively constant over the nine years, however it did not. There was a sharp drop (-18.7 percent) between FY 2009 and FY 2010 with smaller drops in the following years. Because this drop started in FY 2010, it most likely has nothing to do with the loss of airmen (ANs) or changes in maintenance hour tracking changes which both started in FY 2007. The drop is most pronounced in the strike fighter (VFA) and patrol (VP) squadrons. This aspect of the analysis needs to be examined more closely to determine the possible causes.

Annual primary NMCM hours

Figure 68 shows changes in squadron primary[3] annual not mission capable due to maintenance (NMCM) hours from FY 2004 to FY 2012.

Figure 68. Navy squadron annual NMCM hours, FY 2004 to FY 2012

Primary not mission capable due to maintenance hours														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	846,801	183,316	139,450	87,151	91,947	22,845	41,201	8,408	185,901	136,922	122,586	75,000	59,436	2,000,965
2005	754,890	137,975	140,747	79,363	82,943	18,073	48,101	5,466	172,072	155,695	112,833	56,276	74,343	1,838,777
2006	752,609	152,094	134,460	84,223	66,472	18,497	36,063	3,657	142,930	166,316	97,565	64,422	56,180	1,775,489
2007	817,475	172,264	136,954	57,964	66,479	15,641	33,823	7,952	117,084	171,524	98,029	54,755	93,037	1,842,981
2008	928,682	117,520	151,650	73,669	57,222	13,058	36,870	8,005	148,972	153,438	103,416	59,770	81,673	1,933,946
2009	962,376	115,635	139,226	66,643	66,039	11,873	51,421	5,951	140,393	133,991	111,254	54,225	82,224	1,941,252
2010	985,862	138,857	120,566	75,701	66,261	15,252	27,872	9,031	229,930	171,714	131,141	54,463	62,029	2,088,681
2011	796,657	182,368	120,784	92,183	61,214	13,202	45,531	8,265	297,594	165,340	158,680	62,618	68,780	2,073,215
2012	834,648	175,244	148,322	99,279	85,107	44,894	32,417	16,545	451,641	196,012	210,411	75,354	43,232	2,413,106
Change	-1.4%	-4.4%	6.4%	13.9%	-7.4%	96.5%	-21.3%	96.8%	142.9%	43.2%	71.6%	0.5%	-27.3%	20.6%
	-12,154	-8,072	8,873	12,128	-6,841	22,049	-8,784	8,137	265,740	59,091	87,825	354	-16,203	412,141

Table 31 provides a summary of the total column from figure 68.

3. Primary means that the supply-caused delays and overlapping maintenance related delays have been removed leaving only the maintenance related hours.

Table 31. Navy squadron annual NMCM hours, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
2,413,106	1,989,824	1,775,489	20.6%	412,141	190,990	0.10

The total annual squadron NMCM hours increased by 412 thousand hours or 20.6 percent between FY 2004 and FY 2012. Figures 69 and 70 provide the same breakdowns, but segmented into fixed-wing and rotary squadron totals.

Figure 69. Fixed-wing primary NMCM hours

Fixed-wing primary NMCM hours									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	91,947	139,450	41,201	87,151	183,316	22,845	8,408	846,801	1,421,120
2005	82,943	140,747	48,101	79,363	137,975	18,073	5,466	754,890	1,267,557
2006	66,472	134,460	36,063	84,223	152,094	18,497	3,657	752,609	1,248,076
2007	66,479	136,954	33,823	57,964	172,264	15,641	7,952	817,475	1,308,552
2008	57,222	151,650	36,870	73,669	117,520	13,058	8,005	928,682	1,386,676
2009	66,039	139,226	51,421	66,643	115,635	11,873	5,951	962,376	1,419,164
2010	66,261	120,566	27,872	75,701	138,857	15,252	9,031	985,862	1,439,403
2011	61,214	120,784	45,531	92,183	182,368	13,202	8,265	796,657	1,320,204
2012	85,107	148,322	32,417	99,279	175,244	44,894	16,545	834,648	1,436,456
Change	-7.4%	6.4%	-21.3%	13.9%	-4.4%	96.5%	96.8%	-1.4%	1.1%
	-6,841	8,873	-8,784	12,128	-8,072	22,049	8,137	-12,154	15,336

Figure 70. Rotary primary NMCM hours

Rotary primary NMCM hours						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	75,000	136,922	122,586	59,436	185,901	579,845
2005	56,276	155,695	112,833	74,343	172,072	571,220
2006	64,422	166,316	97,565	56,180	142,930	527,413
2007	54,755	171,524	98,029	93,037	117,084	534,429
2008	59,770	153,438	103,416	81,673	148,972	547,270
2009	54,225	133,991	111,254	82,224	140,393	522,088
2010	54,463	171,714	131,141	62,029	229,930	649,277
2011	62,618	165,340	158,680	68,780	297,594	753,011
2012	75,354	196,012	210,411	43,232	451,641	976,651
Change	0.5%	43.2%	71.6%	-27.3%	142.9%	68.4%
	354	59,091	87,825	-16,203	265,740	396,806

Although the primary NMCM hours for both fixed-wing and rotary aircraft increased, the increase for fixed-wing was only 1.1 percent or 15,336 hours. The rotary squadrons had a much larger increase of 396,806 hours or 68.4 percent. The majority of the increase was in the HSC squadrons.

Annual primary PMCM hours

Figure 71 shows the annual primary partially mission capable due to maintenance (PMCM) hours from FY 2004 to FY 2012.

Figure 71. Navy squadron annual PMCM hours, FY 2004 to FY 2012

Primary partially mission capable due to maintenance hours														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	619,667	181,202	78,142	47,789	61,535	24,163	23,796	11,222	126,694	114,218	87,115	47,681	20,344	1,443,567
2005	615,666	126,633	98,539	48,702	61,866	17,620	26,671	5,724	115,286	121,736	68,916	40,201	20,426	1,367,985
2006	677,905	130,588	85,779	39,317	55,471	14,007	22,834	4,450	107,052	107,430	91,202	42,920	18,398	1,397,353
2007	721,688	127,201	94,864	36,765	71,503	15,407	25,514	10,793	116,464	110,105	73,440	53,534	22,866	1,480,145
2008	853,559	89,721	88,483	41,556	70,510	19,643	41,381	11,608	127,392	118,534	87,772	53,293	41,746	1,645,197
2009	873,559	90,460	85,993	54,834	55,739	20,330	30,687	9,016	153,910	148,358	98,191	48,430	34,805	1,704,312
2010	977,707	111,329	94,963	74,915	59,439	24,931	78,874	10,919	244,537	136,469	120,125	64,498	18,259	2,016,966
2011	732,853	111,853	97,657	73,239	58,404	12,777	42,863	8,605	241,155	141,870	130,467	63,085	16,541	1,731,369
2012	760,834	188,416	59,554	91,069	53,402	20,699	24,870	17,372	218,304	132,318	108,495	38,496	42,703	1,756,532
Change	22.8%	4.0%	-23.8%	90.6%	-13.2%	-14.3%	4.5%	54.8%	72.3%	15.8%	24.5%	-19.3%	109.9%	21.7%
	141,167	7,215	-18,588	43,280	-8,133	-3,463	1,073	6,150	91,610	18,101	21,380	-9,185	22,360	312,965

Table 32 provides a summary of the total column from figure 71.

Table 32. Navy squadron annual PMCM hours, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
2,016,966	1,615,936	1,367,985	21.7%	312,965	212,130	0.13

The total annual squadron PMCM hours increased by 313 thousand hours or 21.7 percent between FY 2004 and FY 2012. Figures 72 and 73 provide the same breakdowns, but segmented into fixed-wing and rotary squadron totals.

The fixed-wing squadrons added more annual primary PMCM hours—169,699, or 16.1 percent—than did the rotary squadrons—

Figure 72. Fixed-wing primary PMCM hours

Fixed-wing primary PMCM hours									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	61,535	78,142	23,796	47,789	181,202	24,163	11,222	619,667	1,047,516
2005	61,866	98,539	26,671	48,702	126,633	17,620	5,724	615,666	1,001,421
2006	55,471	85,779	22,834	39,317	130,588	14,007	4,450	677,905	1,030,352
2007	71,503	94,864	25,514	36,765	127,201	15,407	10,793	721,688	1,103,735
2008	70,510	88,483	41,381	41,556	89,721	19,643	11,608	853,559	1,216,461
2009	55,739	85,993	30,687	54,834	90,460	20,330	9,016	873,559	1,220,618
2010	59,439	94,963	78,874	74,915	111,329	24,931	10,919	977,707	1,433,077
2011	58,404	97,657	42,863	73,239	111,853	12,777	8,605	732,853	1,138,250
2012	53,402	59,554	24,870	91,069	188,416	20,699	17,372	760,834	1,216,215
Change	-13.2%	-23.8%	4.5%	90.6%	4.0%	-14.3%	54.8%	22.8%	16.1%
	-8,133	-18,588	1,073	43,280	7,215	-3,463	6,150	141,167	168,699

Figure 73. Rotary primary PMCM hours

Rotary primary PMCM hours						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	47,681	114,218	87,115	20,344	126,694	396,051
2005	40,201	121,736	68,916	20,426	115,286	366,564
2006	42,920	107,430	91,202	18,398	107,052	367,001
2007	53,534	110,105	73,440	22,866	116,464	376,410
2008	53,293	118,534	87,772	41,746	127,392	428,736
2009	48,430	148,358	98,191	34,805	153,910	483,694
2010	64,498	136,469	120,125	18,259	244,537	583,888
2011	63,085	141,870	130,467	16,541	241,155	593,118
2012	38,496	132,318	108,495	42,703	218,304	540,317
Change	-19.3%	15.8%	24.5%	109.9%	72.3%	36.4%
	-9,185	18,101	21,380	22,360	91,610	144,266

144,266, or 36.4 percent. The greater percentage growth for the rotary squadrons was the result of fewer baseline hours.

Annual equipment in service (EIS) hours

Figure 74 provides changes in squadron total annual EIS hours from FY 2004 to FY 2012..

Table 33 provides a summary of the total column from figure 74.

The total annual squadron EIS hours increased slightly—86,967 hours, or 0.9 percent—between FY 2004 and FY 2012. This increase in EIS hours is approximately what we anticipated, since the number

Figure 74. Navy squadron annual EIS hours, FY 2004 to FY 2012

Annual equipment in service (EIS) hours														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	4,523,062	945,609	471,126	598,318	352,372	159,310	254,090	55,953	1,103,752	694,696	442,968	346,854	183,220	10,131,330
2005	4,367,739	699,560	528,485	575,112	376,868	154,525	271,353	55,735	1,067,699	687,202	438,335	319,264	182,258	9,724,135
2006	4,238,182	708,107	542,263	561,353	327,606	154,119	314,158	43,470	855,684	671,536	432,163	325,632	168,057	9,342,330
2007	4,514,847	714,932	531,721	559,880	362,056	150,378	325,313	52,050	890,370	687,798	431,619	352,274	210,188	9,783,426
2008	4,732,382	475,132	535,799	562,828	351,600	131,735	334,958	50,110	1,010,884	673,644	484,008	322,672	225,970	9,891,722
2009	4,761,300	528,570	593,743	576,482	362,479	118,574	329,165	40,362	1,083,230	707,830	543,779	338,463	227,547	10,211,524
2010	4,705,293	606,595	656,313	546,660	370,517	144,659	310,961	42,552	1,260,067	697,522	669,953	356,403	191,052	10,558,547
2011	3,949,212	701,618	743,330	557,237	358,478	154,937	332,005	41,220	1,406,589	707,041	761,669	338,302	206,258	10,257,896
2012	3,827,053	694,789	797,946	553,522	349,117	174,528	337,058	48,868	1,444,199	627,101	867,941	308,199	187,976	10,218,297
Change	-15.4%	-26.5%	69.4%	-7.5%	-0.9%	9.6%	32.7%	-12.7%	30.8%	-9.7%	95.9%	-11.1%	2.6%	0.9%
	-696,009	-250,820	326,820	-44,796	-3,255	15,218	82,968	-7,085	340,447	-67,595	424,973	-38,655	4,756	86,967

Table 33. Navy squadron annual EIS hours, total number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
10,558,547	10,013,245	9,342,330	0.9%	86,967	362,941	0.04

of aircraft in service increased by 40. Figures 75 and 76 provide the same breakdowns, but segmented into fixed-wing and rotary squadron totals.

Figure 75. Fixed-wing annual EIS hours

Fixed-wing annual equipment in service (EIS) hours									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	352,372	471,126	254,090	598,318	945,609	159,310	55,953	4,523,062	7,359,840
2005	376,868	528,485	271,353	575,112	699,560	154,525	55,735	4,367,739	7,029,377
2006	327,606	542,263	314,158	561,353	708,107	154,119	43,470	4,238,182	6,889,258
2007	362,056	531,721	325,313	559,880	714,932	150,378	52,050	4,514,847	7,211,177
2008	351,600	535,799	334,958	562,828	475,132	131,735	50,110	4,732,382	7,174,544
2009	362,479	593,743	329,165	576,482	528,570	118,574	40,362	4,761,300	7,310,675
2010	370,517	656,313	310,961	546,660	606,595	144,659	42,552	4,705,293	7,383,550
2011	358,478	743,330	332,005	557,237	701,618	154,937	41,220	3,949,212	6,838,037
2012	349,117	797,946	337,058	553,522	694,789	174,528	48,868	3,827,053	6,782,881
Change	-0.9%	69.4%	32.7%	-7.5%	-26.5%	9.6%	-12.7%	-15.4%	-7.8%
	-3,255	326,820	82,968	-44,796	-250,820	15,218	-7,085	-696,009	-576,959

The fixed-wing squadrons lost 7.8 percent, or 576,959 hours, of annual EIS hours; however, the EIS annual hours for the rotary squadrons increased by 24.0 percent, or 663,926 hours.

Figure 76. Rotary annual EIS hours

Rotary annual equipment in service (EIS) hours						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	346,854	694,696	442,968	183,220	1,103,752	2,771,490
2005	319,264	687,202	438,335	182,258	1,067,699	2,694,758
2006	325,632	671,536	432,163	168,057	855,684	2,453,072
2007	352,274	687,798	431,619	210,188	890,370	2,572,249
2008	322,672	673,644	484,008	225,970	1,010,884	2,717,178
2009	338,463	707,830	543,779	227,547	1,083,230	2,900,849
2010	356,403	697,522	669,953	191,052	1,260,067	3,174,997
2011	338,302	707,041	761,669	206,258	1,406,589	3,419,859
2012	308,199	627,101	867,941	187,976	1,444,199	3,435,416
Change	-11.1%	-9.7%	95.9%	2.6%	30.8%	24.0%
	-38,655	-67,595	424,973	4,756	340,447	663,926

Aircraft maintenance support rate

Figure 77 shows changes in our readiness figure of merit for squadron aircraft—*maintenance support rate* (MSR)—over the study time period.

Figure 77. Navy squadron aircraft MSR, FY 2004 to FY 2012

Maintenance support rates														
FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2004	68.8%	62.3%	57.8%	81.7%	56.1%	70.5%	70.4%	61.5%	69.3%	63.9%	54.5%	67.3%	56.8%	66.5%
2005	69.5%	63.7%	56.3%	82.7%	60.9%	77.1%	68.3%	77.6%	71.4%	60.3%	59.5%	72.2%	48.8%	67.7%
2006	66.8%	60.4%	61.3%	83.1%	63.5%	79.1%	76.7%	80.0%	70.3%	59.5%	57.3%	69.4%	55.8%	67.4%
2007	66.7%	59.5%	57.6%	86.1%	61.5%	79.2%	78.8%	72.5%	73.6%	59.9%	60.2%	70.2%	46.0%	67.5%
2008	63.3%	54.8%	56.7%	85.5%	63.6%	71.6%	73.2%	62.0%	73.1%	59.8%	60.8%	64.9%	45.1%	65.6%
2009	62.9%	61.5%	62.1%	83.1%	65.9%	69.8%	73.3%	62.1%	73.2%	60.2%	63.3%	69.7%	48.4%	66.7%
2010	59.0%	57.7%	62.2%	79.3%	66.0%	72.1%	63.7%	54.2%	63.2%	55.8%	62.6%	66.1%	58.1%	63.1%
2011	62.7%	58.2%	65.9%	76.0%	66.9%	84.1%	72.7%	59.0%	63.3%	55.4%	63.9%	63.8%	59.1%	64.8%
2012	59.7%	46.1%	69.4%	73.6%	59.0%	62.4%	79.4%	43.1%	56.5%	47.7%	67.1%	66.3%	53.7%	60.6%
Change	-13.3%	-26.1%	20.1%	-10.0%	5.3%	-11.6%	12.8%	-29.9%	-18.4%	-25.4%	23.3%	-1.4%	-5.5%	-8.8%
	-9.2%	-16.3%	11.6%	-8.2%	2.9%	-8.2%	9.0%	-18.4%	-12.8%	-16.2%	12.7%	-1.0%	-3.1%	-5.8%

Table 34 provides a summary of the total column from figure 64.

Table 34. Navy squadron aircraft MSR, average number analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
67.7%	55.5%	60.6%	-8.8%	-5.8%	2.4%	0.04

The total annual squadron aircraft MSR decreased by 5.8 percentage points[4] or 8.8 percent between FY 2004 and FY 2012. Figures 78 and 79 provide the same breakdowns, but segmented into fixed-wing and rotary squadron totals.

Figure 78. Fixed-wing maintenance support rates

Fixed-wing maintenance support rates									
FY	VAW	VAQ	VFC	VR	VP	VQ	VPU	VFA	TOTAL
2004	56.1%	57.8%	70.4%	81.7%	62.3%	70.5%	61.5%	68.8%	67.0%
2005	60.9%	56.3%	68.3%	82.7%	63.7%	77.1%	77.6%	69.5%	68.4%
2006	63.5%	61.3%	76.7%	83.1%	60.4%	79.1%	80.0%	66.8%	68.2%
2007	61.5%	57.6%	78.8%	86.1%	59.5%	79.2%	72.5%	66.7%	67.8%
2008	63.6%	56.7%	73.2%	85.5%	54.8%	71.6%	62.0%	63.3%	65.6%
2009	65.9%	62.1%	73.3%	83.1%	61.5%	69.8%	62.1%	62.9%	66.6%
2010	66.0%	62.2%	63.7%	79.3%	57.7%	72.1%	54.2%	59.0%	63.7%
2011	66.9%	65.9%	72.7%	76.0%	58.2%	84.1%	59.0%	62.7%	66.0%
2012	59.0%	69.4%	79.4%	73.6%	46.1%	62.4%	43.1%	59.7%	61.6%
Change	5.3%	20.1%	12.8%	-10.0%	-26.1%	-11.6%	-29.9%	-13.3%	-8.0%
	2.9%	11.6%	9.0%	-8.2%	-16.3%	-8.2%	-18.4%	-9.2%	-5.4%

Figure 79. Rotary maintenance support rates

Rotary maintenance support rates						
FY	HS	HSL	HSM	HM	HSC	TOTAL
2004	67.3%	63.9%	54.5%	56.8%	69.3%	64.8%
2005	72.2%	60.3%	59.5%	48.8%	71.4%	65.8%
2006	69.4%	59.5%	57.3%	55.8%	70.3%	65.0%
2007	70.2%	59.9%	60.2%	46.0%	73.6%	66.7%
2008	64.9%	59.8%	60.8%	45.1%	73.1%	65.6%
2009	69.7%	60.2%	63.3%	48.4%	73.2%	66.9%
2010	66.1%	55.8%	62.6%	58.1%	63.2%	61.6%
2011	63.8%	55.4%	63.9%	59.1%	63.3%	61.6%
2012	66.3%	47.7%	67.1%	53.7%	56.5%	58.0%
Change	-1.4%	-25.4%	23.3%	-5.5%	-18.4%	-10.5%
	-1.0%	-16.2%	12.7%	-3.1%	-12.8%	-6.8%

The MSRs for both squadron classes declined. The fixed-wing squadrons lost 5.4 percentage points or 8.0 percent, whereas the rotary squadrons lost 6.8 percentage points or 10.5 percent. The larger MSR

4. Note that rounding error results in the change amounts being different from simple subtraction results.

drops in the rotary squadrons were generated by the antisubmarine light (HSL) and sea combat (HSC) units.

Summary of changes

Figure 80 provides a comparison of the percent of change for each of the outcome measures from FY 2004 to FY 2012.

Figure 80. Navy maintenance outcome measures, percent change factor summary

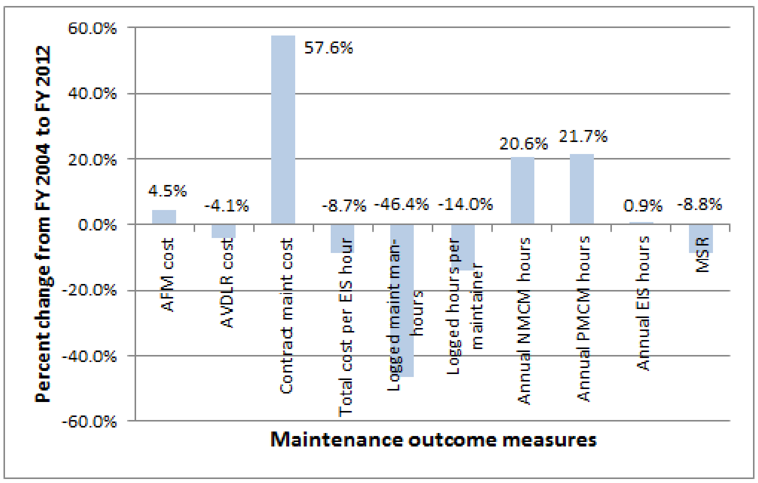
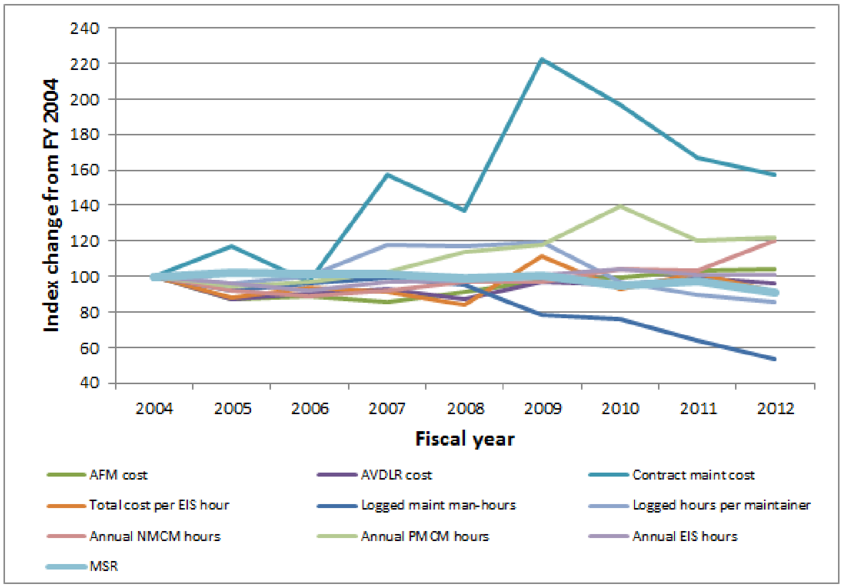


Figure 81 provides the same information but on a timeline that shows the index change each year when compared to the baseline year of FY 2004.

Figure 81. Navy maintenance outcome measures, index change timeline



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Estimated effects of factors on the MSR

In this section, we present estimates of the effects of various factors on the MSR. First, we estimate these effects by graphing Navy-wide changes over time in the MSR and the factors that may affect it. Graphing the changes allows us to see the strength and direction (positive or negative) of the associations between them. Second, we obtain more rigorous estimates of these effects by regression modeling. Regression modeling quantifies the association between the MSR and each factor, holding the other factors constant at a fixed level.

The regressions estimate the effects of changes in factors at the squadron level (i.e., for a squadron's aircraft) on the average MSR across that squadron's aircraft. However, the regression estimates also can be used to measure how Navy-wide changes in these factors affect the average MSR across all Navy aircraft.

Regressions provide different results than graphing Navy-wide changes over time does. But while regression estimates and graphical estimates are similar to each other, the simpler graphing techniques quickly yields evidence when a particularly strong factor affects the MSR by a certain amount to help focus the more detailed regression analyses.

We examine the time-related changes to the following factors:[5]

- Number of maintainers in the squadron
- FILL rate for the squadron's maintainers
- FIT rate for the squadron's maintainers

5. We also examined whether increases in the number of maintainers in different paygrades and different ratings have different effects on the MSR. Because we detected no difference in effect between the different paygrades and ratings, we do not report those results here.

- Annual logged maintenance hours for the squadron's maintainers, or *number of man-hours*
- Annual O-level contract maintenance cost for the squadron
- Total hours of support from NATEC for the squadron, which is the sum of requests for assistance (RFA), requests for information (RFI), and requests for training (RFT) hours
- Number of aircraft in the squadron[6]
- Average age of aircraft in the squadron[7]
- Average maintainer time in unit for the squadron's maintainers
- Average maintainer time in squadron for the squadron's maintainers
- Average maintainer time servicing T/M/S for the squadron's maintainers[8]

Graphs of changes over time in MSR and factors that may affect it

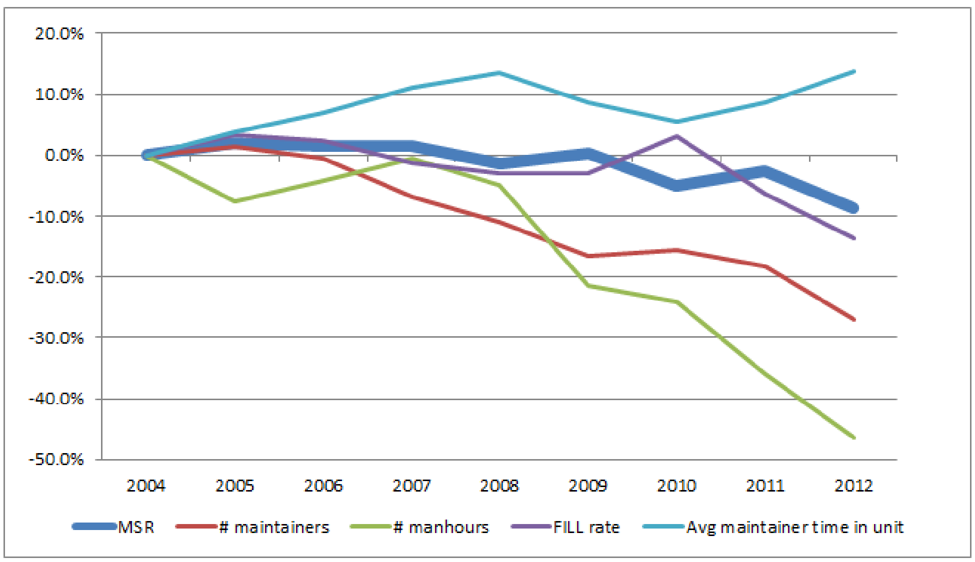
To look for evidence for whether and by how much these factors affect the MSR, we first graph changes over time in the MSR and in the factors. In the graphs, we do not show every factor that we ana-

6. For squadrons that have more than one T/M/S, our data have separate records for each T/M/S. Each of the records has data on the number of aircraft in the squadron of that T/M/S. For instance, a squadron with six F/A-18Cs and eight F/A-18Ds one year would have two records in the data for that year. The record for the F/A-18Cs would say that there are six aircraft, and the record for the F/A-18Ds would say that there are eight aircraft.
7. For squadrons that have more than one T/M/S, the data on average age in the separate records for each T/M/S in the squadron measure the average age across the aircraft of each T/M/S.
8. For squadrons that have more than one T/M/S, the data on average maintainer time servicing T/M/S in the separate records for each T/M/S in the squadron measure the average time servicing T/M/S across the aircraft of each T/M/S.

lyzed in the study—we show only the ones estimated as having important effects from our graphical and regression analyses. Figures 82 and 83 show the relationships between the MSR and these factors.

The graphs show Navy-wide changes over time (aggregates across all of the Navy aircraft in our data). The horizontal axis on these figures shows the fiscal year the data are from. The vertical axis gives the percent change in the MSR or factor between the first year of our dataset (2004) and that year.

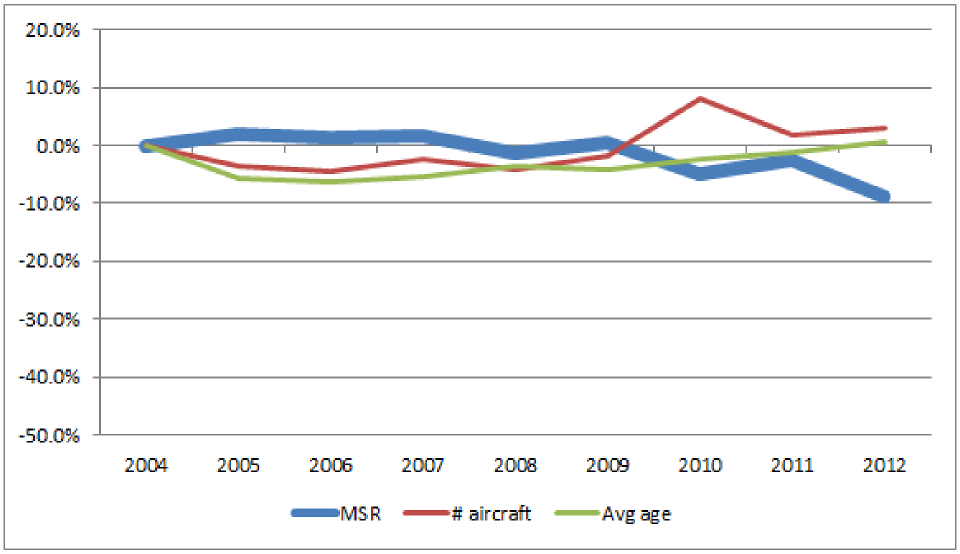
Figure 82. Navy-wide changes over time in MSR and squadron maintenance manpower factors



In figure 82, we see a fairly close positive relationship between the MSR and the number of maintainers; that is, changes in the number of maintainers track changes in the MSR fairly closely. The number of maintainers has the strongest relationship with MSR.

Among the factors shown in figure 82, the number of logged maintenance man-hours has the second-strongest effect on the MSR. Both the MSR and the number of man-hours decline between FY 2004 and FY 2012, and the changes from one year to the next in the number of

Figure 83. Navy-wide changes over time in MSR and squadron characteristics



man-hours are often similar to the changes from one year to the next in the MSR.

The FILL rate declined between FY 2004 and FY 2012, and it declined by more than the MSR did. Changes from one year to the next in the FILL rate are often different from changes in the MSR. Finally, while the MSR declined substantially between FY 2004 and FY 2012, average maintainer time in unit increased slightly.

From figure 82, we see that the number of maintainers and the number of maintenance man-hours have a moderately sized effect on the MSR, that the FILL rate has a smaller effect on the MSR, and that average maintainer time in unit has little effect on the MSR.

In figure 83, we see a fairly close negative relationship between the MSR and the number of aircraft. Most of the changes from year to year in the number of aircraft are similar in size to changes in the MSR, but opposite in direction. The average age of aircraft also has a negative relationship with the MSR, although the negative relationship is not as strong as that between the number of aircraft and the MSR.

Regression analysis results

Our second method of estimating the effects of the factors on the MSR is to use fixed-effect regression modeling.

Regression methods used

Our regressions measure the associations between changes over time in the MSR and changes over time in one specific factor. Regressions answer questions such as, "What if we increased the number of maintainers, but held all the other maintenance factors constant?" Regression estimates have advantages over graphing changes over time. Graphs display correlations between pairs of variables in a given dataset. For example, figure 83 shows that in our data, changes over time in the number of aircraft have a negative correlation with changes in the MSR. However, it might be that, for example, a 10-percent increase in the number of aircraft would cause a decrease in the MSR *only if* the number of maintainers, number of man-hours, and number of NATEC support hours increased by less than 10 percent, did not change, or also decreased. So, to be more certain about the true effects of each factor on the MSR, we use regression techniques to hold the other factors constant.

The data we used in the regression modeling are at the level of squadron T/M/S-year. This means that for every set of aircraft with the same T/M/S within a squadron, we have annual data on the average MSR for those aircraft over the year, as well as annual data on the values of each factor that may affect the MSR.[9]

In our regressions, we control for what T/M/S the aircraft are in each record in the data.[10] This means that each T/M/S has its own "base-

9. Data on the number of man-hours, O-level contract maintenance cost, and hours of support from NATEC are aggregated to get the totals for each of these factors for the year. Data on the other factors are measured at multiple points each year; we took the average across points for them.

10. This means that the regressions include a set of indicator variables, with an indicator variable for each T/M/S in the data.

line" MSR, and changes in the number of maintainers, number of man-hours, average maintainer time in unit, and so forth, may cause the MSR to move away from that baseline level. Furthermore, controlling for T/M/S in the regressions means that the regressions measure whether aircraft T/M/Ss that experienced larger changes between FY 2004 and FY 2012 in the number of maintainers, number of man-hours, average maintainer time in unit, and so forth, also experienced larger changes in the MSR. This measurement of whether larger changes over time in the factors of interest are associated with larger changes in the MSR is how the regressions estimate the effects of the factors on the MSR.

We also control for which fiscal year each record is from.[11] Controlling for fiscal year controls for Navy-wide changes over time in factors that may affect the MSR that are not included in our dataset, such as replacement part availability or changes in maintainer labor productivity per maintenance man-hour.

Appendix A contains additional information about the regression analysis approach.

Regression estimates and discussion

The following graphs show the estimates that we obtained in our regressions of the effects of several factors on the MSR. Only the factors estimated to have statistically significant effects on the MSR are shown in the graphs. Later in the section we discuss the results for all factors, including those that did not have statistically significant effects.

In the graphs, we show the estimated effect on the MSR of a 10-percent increase in a factor over its previous year levels, with the MSR

11. This means that the regressions include an indicator variable for each fiscal year. We also interacted the indicator variables for T/M/S with the variable for fiscal year (which takes the values 2004 to 2012.) Including the interactions between T/M/S and fiscal year means that the baseline MSR for each T/M/S follows its own T/M/S–specific linear time trend. Results without the linear time trends were very similar to those with linear time trends, however.

measured in percentage terms (as a number between 0 and 100). We looked at a 10-percent increase because the factors are measured in different units (some are measured in number of people, others in number of hours, others in number of months, and so forth). Examining all of the estimated effects in percentage terms gives us a clearer sense of which factors have the highest estimated influence on the MSR.

Figure 84 shows the estimated change in MSR for a 10-percent change in each of the significant maintenance factors when the other factors are held constant.

Figure 84. Estimated change in MSR for a 10-percent increase in statistically significant maintenance factors

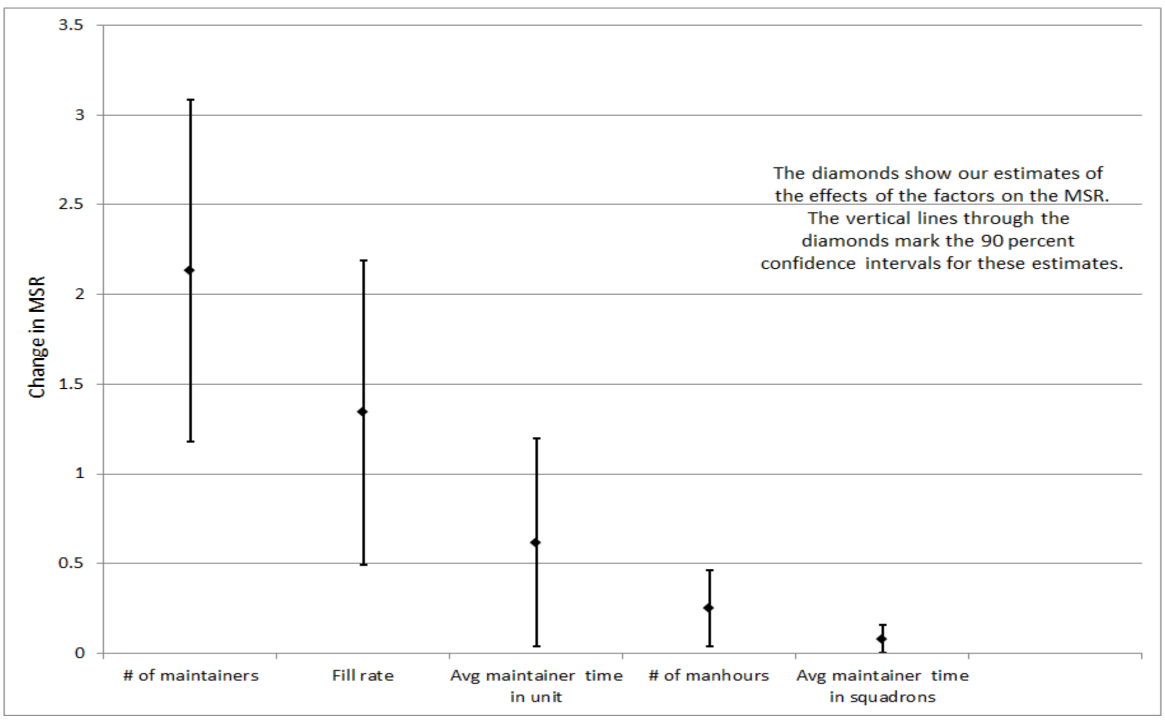
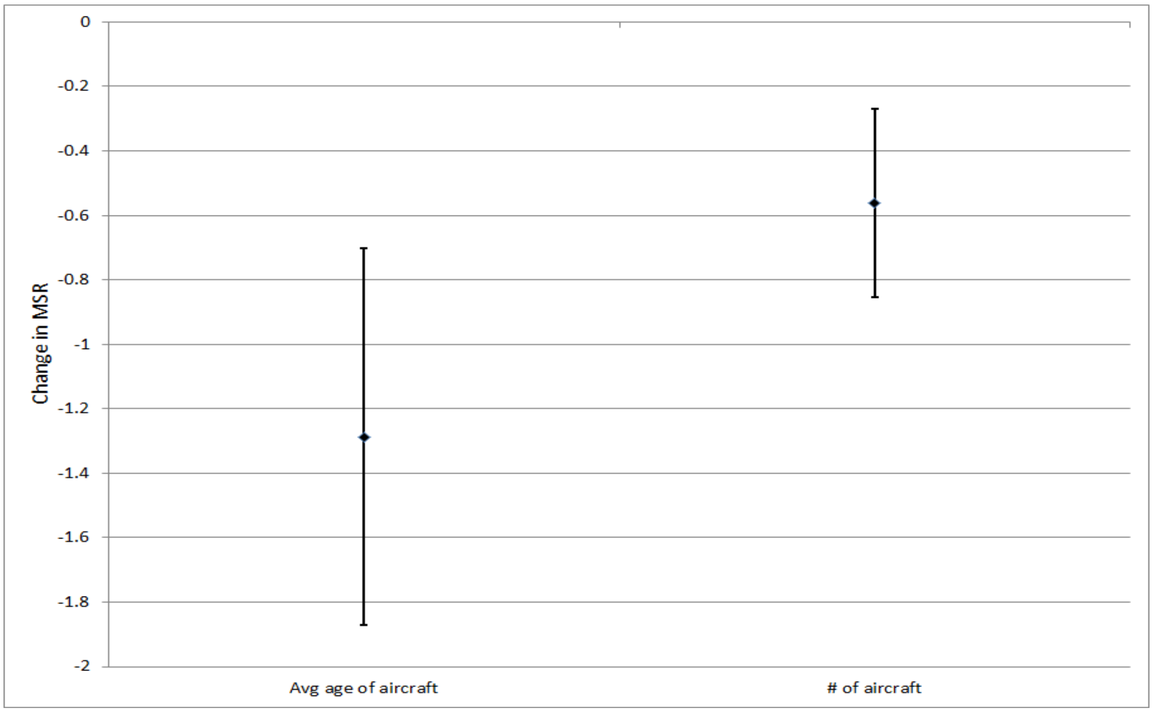


Figure 85 provides the same estimated change in MSR for a 10-percent change in each of the significant maintenance factors when the other factors are held constant, but for those factors with an inverse relationship with the MSR.

Figure 85. Estimated change in MSR for a 10-percent increase in statistically significant squadron characteristics



The diamonds in figures 84 and 85 mark the values of our estimates of the effects of the factors shown on the MSR. The lines around the diamonds show the 90-percent confidence intervals for the estimates. A confidence interval is a range of values that quantifies the amount of uncertainty surrounding an estimate. A 90-percent confidence interval has a 90-percent probability of containing the true value of the effect of the factor on the MSR[12] [1].

If we take these seven significant maintenance factors identified above (five with positive effects and two with negative effects) and plot them against MSR, we can show the relative estimated effect on the MSR. A steeper line indicates a greater effect on the MSR.

Figure 86 provides the plot of number of maintainers.

Figure 86. Estimated effect of the number of maintainers on the MSR

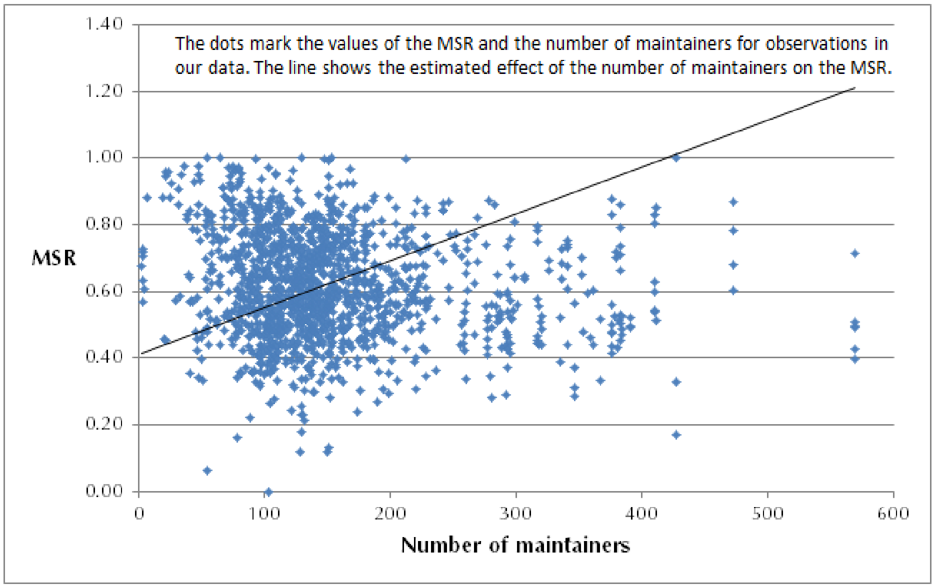


Figure 87 provides the plot of FILL rate.

Figure 88 provides the plot of average maintainer time in unit.

Figure 89 provides the plot of number of logged maintenance man-hours.

Figure 90 provides the plot of average maintainer career time in squadrons.

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12. More precisely, there is a 90-percent probability that it contains the true value of the effect under the assumption that the estimate of the effect is unbiased. We actually have reason to think that the estimates from the regressions may underestimate the effects of some of the factors on the MSR, as we discuss later in this section. If the estimate itself is biased toward being an underestimate, then the 90-percent confidence intervals will have less than a 90-percent probability of containing the true value of the effect.

Figure 87. Estimated effect of the FILL rate on the MSR

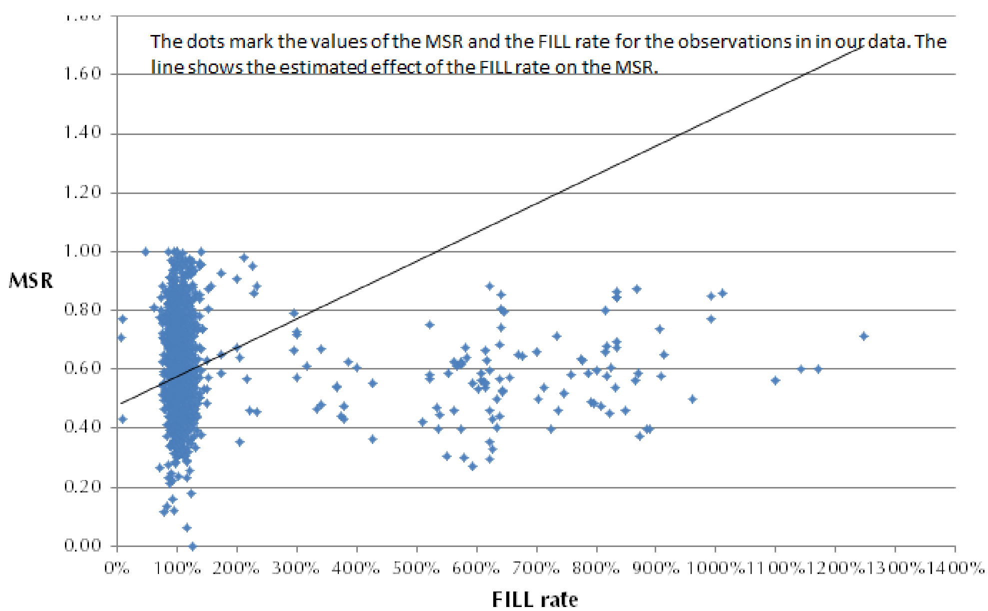


Figure 88. Estimated effect of the average maintainer time in unit on the MSR

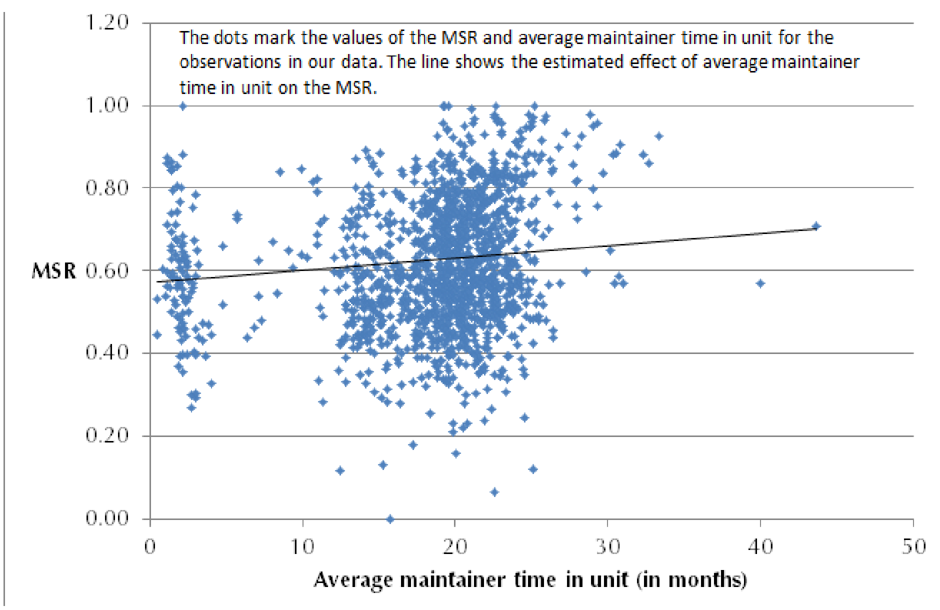


Figure 89. Estimated effect of the number of logged maintenance man-hours on the MSR

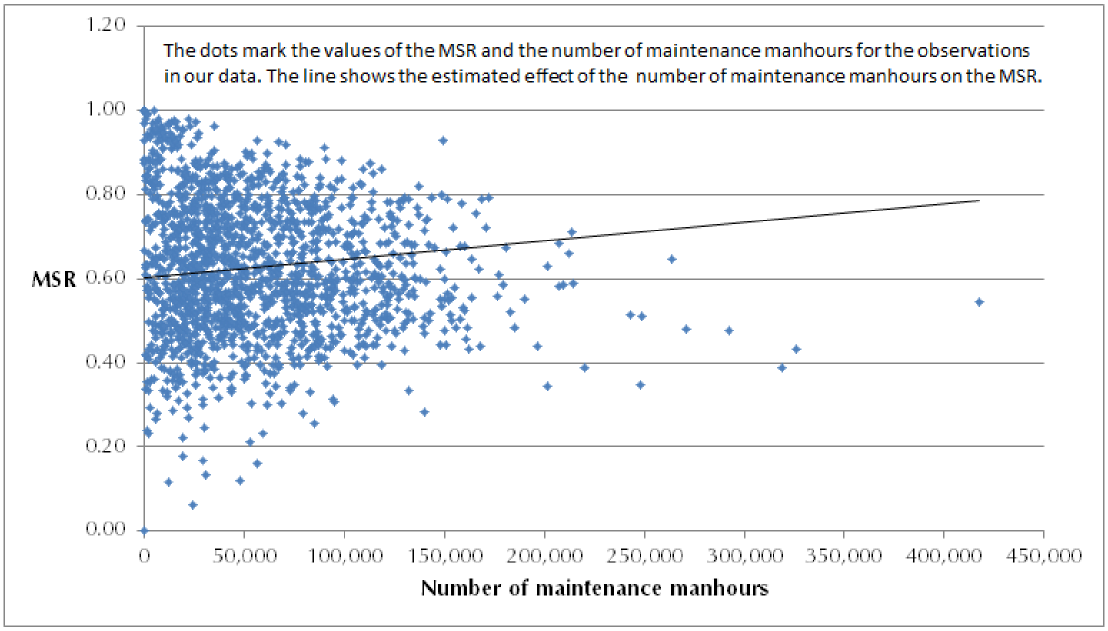


Figure 90. Estimated effect of the average maintainer career time in squadrons on the MSR

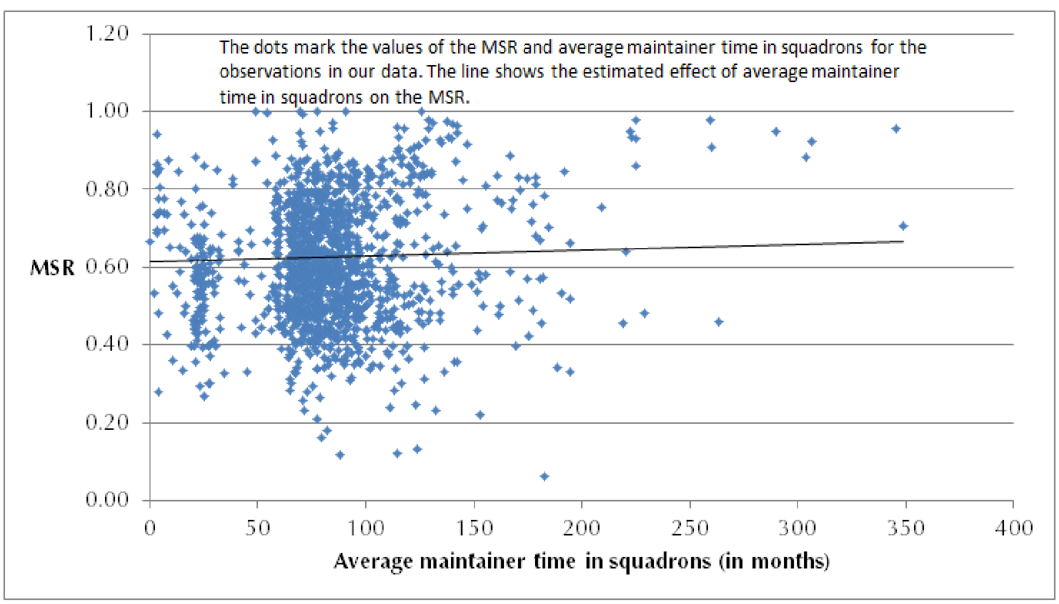


Figure 91 provides the plot of average age of squadron aircraft.

Figure 91. Estimated effect of the average age of squadron aircraft on the MSR

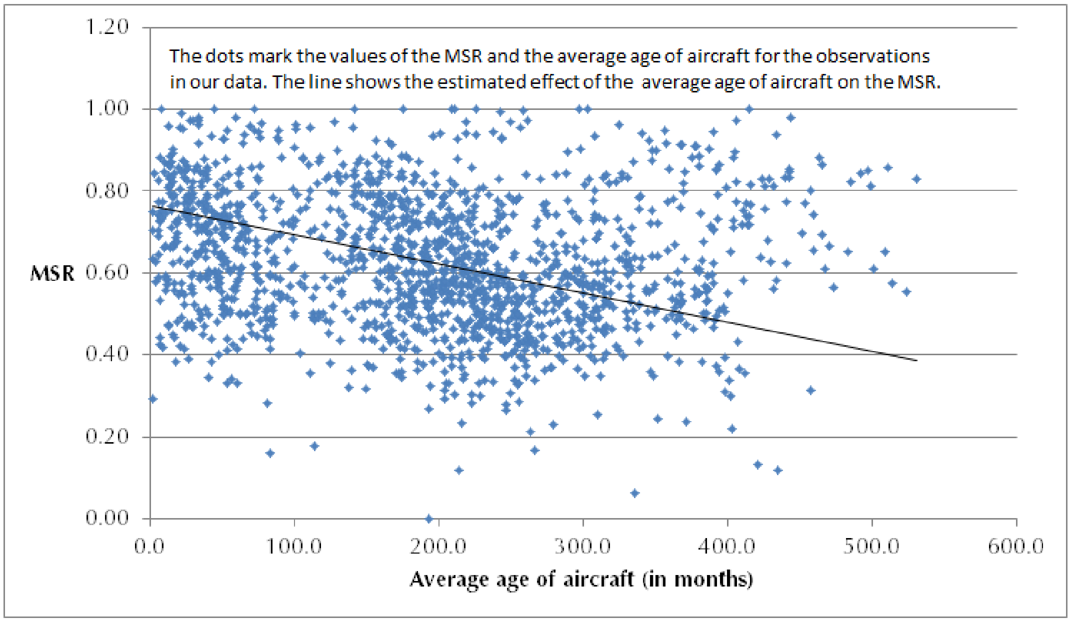
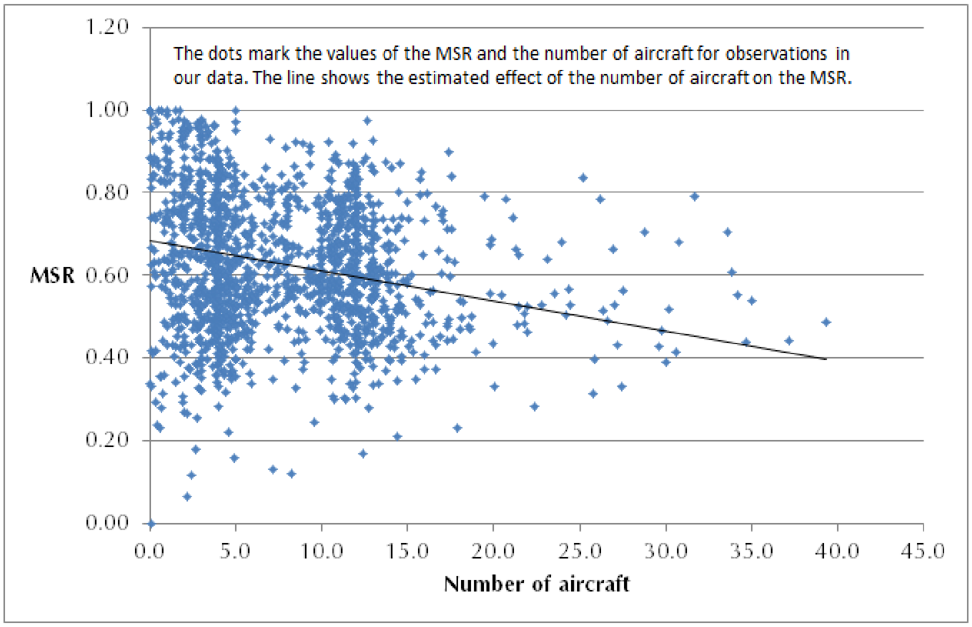


Figure 92 provides the plot of number of squadron aircraft.

Figure 92. Estimated effect of the number of squadron aircraft on the MSR



These plots provide a visual indication of the estimated effects that each of these seven variables has on the output MSR. These effects were generated by holding all the other variables constant each time. In reality, however, this is not what happens; for example, as the number of maintainers changes, the FILL rate also changes and the number of logged maintenance man-hours drops. In reality, the estimated effects accumulate, which adds up to a much greater influence on the MSR.

There are other considerations related to these regression results, as well. When data for a factor are not accurate (i.e., when there is "measurement error"), its regression estimate usually underestimates the effects of that factor on the outcome of interest [2]. Furthermore, the degree of underestimation is usually worse when "fixed effects" (i.e., of indicator variables such as ours to control for aircraft T/M/S and fiscal year) are included in the regressions (as we have done).

Moreover, a "reverse causality" problem could be causing us to underestimate the effects of logged maintenance man-hours. Increases in man-hours likely cause an increase in the MSR, but decreases in the MSR may also cause an increase in the number of man-hours of maintenance to be performed.[13] The association measured in the regressions between changes in man-hours and changes in the MSR is a combination of any positive effect of man-hours on the MSR and any negative effect of the MSR on the number of man-hours of maintenance that needs to be done. In reality, if decreases in the MSR do indeed cause more man-hours of work to be done, our regressions will have underestimated the effect of the decreases on the MSR [3].

Results for variables not shown in figures above

Figures 84 and 85 above show our estimates only for the factors that we found to have statistically significant effects on the MSR. We modeled the following factors, but found that they had no statistically significant effects:

- **The FIT rate.** Changes in the FIT rate had small negative associations with the MSR (0.45-point decrease in MSR for a 10-percent increase in the FIT rate), and the confidence interval for the estimated effect was large (0.45 plus or minus 0.93 percentage points). However, the FIT rate did not change much between FY 2004 and FY 2012 (see figure 31). The lack of variance in the FIT rate over time in our data might have made it difficult to detect an effect of the FIT rate on the MSR.

- **Average maintainer career time with T/M/S.** We did not detect any estimated effect of changes in this factor on the MSR. This is unexpected. We believe that the main reason we did not detect an effect is that the factor relationship is not linear in nature. For example, when a new aircraft model is introduced to the fleet, the learning curve is steep and maintenance expe-

13. The reverse causality problem here is analogous to the problem of estimating the effects of the number of police officers on crime rates. Increases in the number of officers could cause the crime rate to decline, but increases in the crime rate could cause increases in the number of officers on the police force. This makes it difficult to estimate the effects of increases in the number of officers on the crime rate [3].

rience with the model has a large impact on the MSR. This is why outside contractor support is so helpful at such times. However, once maintainers gain some experience with the new model, *additional* experience has less and less effect on the MSR. The knee in this curve is probably around two or three years of experience, but additional analysis would be necessary to determine this with more accuracy. Since our study covers the much longer time interval of nine years, any short-term experience effect is lost when compared with the other factors.

- **The total number of hours of NATEC support given to the squadron.** We did not detect any estimated effect of increases in the number of NATEC support hours a squadron gets on the MSR. However, there are at least two reasons why. One reason the effect may have been difficult to detect is reverse causality; that is, squadrons may ask for more support from NATEC when the MSR is low. The second reason is that NATEC is a small program—the total number of logged maintenance man-hours per year over all squadrons in our data is 9.8 million hours, whereas the average number of NATEC support hours per year over all squadrons is about 28,000. A small program such as NATEC is unlikely to be a key driver of the MSR, and small causal effects are difficult to detect in regressions.

- **Annual O-level contract maintenance cost for the squadron.** We did not detect any estimated effect of changes in this factor on the MSR. However, as with NATEC, it may be difficult to detect an effect because O-level contracting is a small program—contract maintenance costs are only 7 percent of total annual maintenance costs.

Drivers of Navy-wide changes in MSR, FY 2004–2012

As shown in figure 70, the MSR of the aircraft in the squadrons in our data declined, from 66.5 percent in FY 2004 to 60.6 percent in FY 2012—a decline of 5.8 percentage points over the study time period.

Changes from FY 2004 to FY 2012 in the factors estimated by our regressions as having statistically significant effects on the MSR caused an estimated 9.5 percent reduction in the MSR. The contributions to that estimate from the specific estimated reductions and increases in each factor shown in figures 84 and 85 are as follows:

- 5.8 percent reduction in MSR caused by the 27.0 percent reduction in the number of maintainers
- 2.3 percent reduction in MSR caused by the13.6 percent reduction in FILL rate
- 1.2 percent reduction in MSR caused by the 46.4 percent reduction in number of logged maintenance man-hours
- 0.2 percent reduction in MSR caused by the 2.9 percent increase in number of aircraft
- 0.001 percent reduction in MSR caused by the 0.7 percent increase in average aircraft age
- 0.007 percent increase in MSR caused by the 13.8 percent increase in average maintainer time in unit
- 0.0008 percent increase in MSR caused by the 11.6 percent increase in average maintainer time in squadrons

Our data analysis estimated that four factors—the number of maintainers, the FILL rate, the number of logged maintenance man-hours, and average maintainer time in unit—have the strongest effects on the MSR.

That estimated 9.5 percent is a larger decline than the 8.8 percent decline that actually occurred; changes in factors that affect the MSR but that we did not include in our regression model may have offset a portion of the decline in the MSR caused by the factors that we did include.

Conclusion

The intent of this research was to examine the relationships between relevant O-level Navy aviation maintenance factors and aircraft readiness. We developed a figure of merit, which we called the *maintenance support rate* (MSR). The MSR is the total squadron aircraft availability in hours less the hours aircraft are unavailable for maintenance reasons divided by the total availability. We collected information on almost all the Navy's aviation squadrons that are involved in operational missions. We found marked differences between fixed-wing and rotary squadrons. As a result, we provide separate breakouts for most maintenance factor trend analyses.

The MSR for most squadrons has declined over the nine fiscal years of the study period. We looked at which maintenance factors had the greatest variation and change over the period and, through a fixed-effect regression analysis, identified which ones had the greatest influence on the MSR.

Maintenance factors with greatest changes

We found that the following factors experienced the greatest changes during the period of our analysis:

- Constant dollar contract maintenance cost allocated to squadrons (57.6 percent)
- Total annual PMCM hours (21.7 percent)
- Total annual NMCM hours (20.6 percent)
- Total logged maintenance hours per maintainer (–14.0 percent)
- Number of enlisted maintenance personnel in the squadrons (–27.0 percent)

- Number of enlisted E6 maintenance personnel in the squadrons (–30.8 percent)
- Number of enlisted E5 maintenance personnel in the squadrons (–31.1 percent)
- Number of enlisted E1 to E3 maintenance personnel in the squadrons (–42.1 percent)
- Total annual logged maintenance hours (–46.4 percent)

Maintenance factors with greatest influence on MSR

Through our regression analyses we determined that the following O-level maintenance factors have the greatest influence on the squadron MSR:

- Number of maintainers in a squadron
- Squadron manpower FILL rate
- Average maintainer time in unit
- Number of logged maintenance man-hours
- Average maintainer career time in squadrons
- Average age of aircraft being maintained
- Number of aircraft being maintained

Original research question findings

The two original focus areas—(1) squadron maintainer experience levels and (2) quantity of outside technical maintenance support provided by NATEC—were determined to not be the current drivers of the MSR decline.

In fact, average levels of experience in the current unit, career time in squadrons, and career time with T/M/S have actually increased over the nine years. Regarding NATEC support, we could not gather complete NATEC workload data before FY 2009, which was the first full year it used the ELAR II data capture system; however, since then, its level of support for O-level squadrons has not decreased and the average duration of its training events has increased.

Current analysis findings

The findings from our analysis suggest that the decline in MSR is driven mostly by two factors: (1) the reduction in logged maintenance man-hours resulting from fewer enlisted maintainers assigned to squadrons and (2) a reduced number of hours per maintainer for the ones who are still there.

Course of action recommendation

Based on our findings, and as a course of action to control costs and stabilize the squadron MSRs, we recommend the following actions be investigated:

- Consider increasing tour lengths for maintainer assignments, based on that factor's positive effect on MSR, working closely with OPNAV N1 to assess potential personnel-related impacts.
- Closely investigate the drop in logged maintenance hours per maintainer, to determine what is causing the loss of maintenance productivity.
- Perform a cost-benefit analysis with respect to restoring the number of enlisted maintainers in the squadrons to levels closer to pre–FY 2007 numbers.
- Revisit the decision to remove nonrated enlisted from the squadrons, as this action may have diverted Petty Officers from aircraft maintenance duties to deal with tasks previously accomplished by the junior enlisted.
- Coordinate a central repository of all fleet aviation unit FRP cycle histories, as this information is currently available only for carrier-based squadrons.
- Improve and better publicize access to NATEC support. The most useful publicity would be a list of contacts for not only NATEC but also the field service teams and other providers of

emergent technical support and training. Commander Naval Air Forces (CNAF) could publish this listing on a SharePoint site, which would include the pertinent points of contact by platform, community, and location. MyNATEC.web could be included as a module within DECKPLATE to integrate and streamline the NATEC request process.

- More formally integrate NATEC squadron technical maintenance training into the predeployment workup phase of the squadron FRP cycle in order to better prepare squadrons for deployment.
- Establish a centralized Navy database of all contract technical maintenance support, especially as it relates to the O-level units, in order to de-conflict duplicated support and better avoid wasted in-house support efforts.
- Generate separate financial program elements for Navy and Marine Corps engineering technical support requirements.
- Perform additional technical support analysis at the work unit code (WUC) or system level in order to better observe the benefits of outside technical assistance to the overall squadron aircraft MSRs.
- Develop a price performance model to enable future forecasting of outside technical support–level impact on fleet requests for support and aircraft MSRs as a result of adjustments to NATEC resourcing levels.

We believe that implementing some or all of these recommendations will help control O-level maintenance costs and improve the MSRs for all the squadrons.

The primary focus should be on getting more enlisted maintenance personnel back into the squadrons for longer tour lengths in order to generate more logged maintenance hours, with the result of improving aircraft MSR availability.

Appendix A: Additional information on regression models and results

In this appendix, we present the technical details of our regression modeling approach to estimating the effects of the factors examined in this study on the MSR. We also give technical details on the results of this modeling.

Our regression model estimated the coefficients B_1 through B_{103} of the following regression equation. In the regression equation, the subscript "s" denotes squadron; the subscript "a" denotes aircraft T/M/S of a group of aircraft within a squadron that all have the same T/M/S; and "t" denotes fiscal year (the data used in the regression are at the squadron-T/M/S-year level).[14] (Definitions of each of the variables named in the equation follow below the equation.)

$$MSR_{sat} = \text{percent\_change\_from\_avg\_yr\_in\_\#\_of\_maintainer\_billets}_{st}*B_{1,} \quad (1)$$

$$+ \text{percent\_change\_from\_avg\_yr\_in\_\#\_of\_maintainers}_{st}*B_2$$

$$+ \text{percent\_change\_from\_avg\_yr\_in\_\#\_of\_maintenance\_manhours}_{sat}*B_3$$

$$+ \text{percent\_change\_from\_avg\_yr\_in\_\#\_of\_aircraft}_{sat}*B_4$$

$$+ \text{percent\_change\_from\_avg\_yr\_in\_annual\_contract\_maintenance\_cost}_{sat}*B_5$$

$$+ \text{percent\_change\_from\_avg\_yr\_in\_NATEC\_hours}_{st}*B_6$$

$$+ \text{maintenance\_personnel\_FIT\_rate}_{st}*B_7$$

14. A variable in the regression equation with the subscript "sat" varies at the squadron-T/M/S-year level; those with the subscript "st" vary at the squadron-year level because they take the same value for each data record for a squadron with more than one T/M/S of aircraft in a year; and those with subscript "t" vary at the year level only.

$+ \text{FRP\_deploy\_percentage}_{st} * B_8$

$+ \text{average\_maintainer\_time\_in\_unit}_{st} * B_9$

$+ \text{average\_maintainer\_time\_in\_squadrons}_{st} * B_{10}$

$+ \text{average\_maintainer\_time\_with\_T/M/S}_{sat} * B_{11}$

$+ \text{average\_age\_of\_aircraft}_{sat} * B_{12}$

$$+ \sum_{n=2005}^{2012} Indicator(\text{year} = n)_t \times B_{13+(n-2005)}$$

$$+ \sum_{x=1}^{41} Indicator(\text{T/M/S} = x)_{sa} \times B_{20+x}$$

$$+ \sum_{x=1}^{41} Indicator(\text{T/M/S} = x)_{sat} \times \text{year} \times B_{61+x}$$

$+ \varepsilon_{sat}$

Variable definitions

The dependent variable in equation (1), **$\mathbf{MSR_{sat}}$**, is the maintenance support rate for the aircraft in squadron "s" of $T/M/S_a$ over the course of fiscal year "t." In the data for the regressions, the MSR varies in value between 0 and 1.

The first explanatory variable listed in equation (1), "**$\mathbf{percent\_change\_from\_avg\_yr\_in\_\#\_of\_maintainer\_billets_{st}}$**" is the percentage change in the number of maintainer billets in squadron "s" between the current year "t" and the average year (the number for the average year is the average number of maintainer billets in that squadron across all years of data for that squadron in our dataset).[15]

This is the first of seven variables in our regression equation that are measured as percentage changes from the average year, and two others, maintenance_personnel_FIT_rate and FRP_deploy_percentage, are also measured as percentages. We measured many of our variables in percentage terms to account for differences between squadrons in size and aircraft type. The effect of losing 10 billets or having 10 fewer maintainers could easily vary between squadrons depending on how many aircraft they have, what types of aircraft they have (some T/M/Ss may require more work to maintain than others), and how many billets and maintainers the squadron had before the loss of 10 billets or the loss of 10 maintainers. However, it is reasonable to believe that a 10-percentage point change in the number of billets, or the number of maintainers, etc., should have very similar effects on squadrons' MSRs regardless of differences in squadron size and aircraft T/M/S (the squadron MSR itself is measured in percentage terms).

The "**percent_change_from_avg_yr_in_#_of_maintainers**$_{st}$" is the percentage change in the number of maintainers in squadron "s" between the current year "t" and the average year. As explained in the main body of the text, the number of maintainers in a year—as well as our other manpower variables such as number of billets and average maintainer time in unit—are measured as the average number of maintainers between the end of that year and the end of the previous year. End-of-year data are used for these because accurate counts of the number of personnel of different pay grades and ratings in each squadron are collected at the end of each year. The average between the end of this year and the end of last year is used because the MSR data is for the average MSR across all of a squadron's aircraft across the entire year.

"**percent_change_from_avg_yr_in_#_of_maintenance_manhours**$_{sat}$" is the percentage change in the number of maintenance man-hours

15. This variable is computed in the data as follows: [(number of billets in current year – number in average year)/(number in average year)], so when this variable equals 1, it marks a 100-percent increase in the number of billets between the average year and the current year.

for the aircraft of $T/M/S_a$ in squadron “s” between the current year “t” and the average year.

“**percent_change_from_avg_yr_in_#_of_aircraft$_{sat}$**”is the percentage change in the number of aircraft of $T/M/S_a$ in squadron “s” between the current year “t” and the average year. The data on number of aircraft are measured as the average in the squadron across each day of the fiscal year.

“**percent_change_from_avg_yr_in_annual_contract_maintenance_cost$_{sat}$**”is the percentage change in annual O-level contract maintenance cost for the aircraft of $T/M/S_a$ in squadron “s” between the current year “t” and the average year.

“**percent_change_from_avg_yr_in_NATEC_hours$_{st}$**” is the percentage change between the current year “t” and the average year in the number of hours of NATEC support that squadron “s” received over the course of the year.

Hours of NATEC support is the sum of hours of request for information (RFI) support, request for assistance (RFA) support, and request for training (RFT) support. As explained above, accurate data on NATEC hours is available only for FY 2009 through FY 2012. Because of this, in our main regression we actually do not include the variable for hours of NATEC support in the regression; excluding it allows us to better measure the effects of all of the other variables by using data from FY 2004 through FY 2012 in the regression. However, we include “percent_change_from_avg_yr_in_NATEC_hours$_{st}$” in one of our regressions, and another NATEC hours variable, “percent_change_from_avg_yr_in_hours_of_NATEC_support_last_year$_{st}$,” in another. This other NATEC hours variable is the percentage change between the current year “t” and the average year in the number of hours of NATEC support that squadron “s” received over the course of the previous year. We look at previous-year NATEC hours (i.e., lagged NATEC hours) because of the potential for the reverse causality problem to cause us to underestimate the effects of NATEC hours on the MSR: more NATEC hours in year “t” could cause the MSR to decrease in year “t,” but when the MSR is high in year “t,” a squadron may be more likely to ask for more hours of support from NATEC in year “t.” However, while additional NATEC hours in the previous year could cause the MSR in the current year to increase, the expected MSR in future years is arguably less likely to create requests for additional hours of NATEC support in the current year.

Two other variables in the regression are measured in percentage terms, although they are not measured as percentage changes between the current year and the average year. Instead, they are measured as the percentage value of the variable in the current year (and in the data they are measured as a number between 0 and 1, with 1 equaling 100 percent). These variables are:

"**maintenance_personnel_FIT_rate**$_{st}$," the maintenance personnel FIT rate for squadron "s" in year "t" (which is the ratio of total unit maintenance personnel with NEC to total NEC requirements of squadron "s" during fiscal year "t") and "**FRP_deploy_percentage**$_{st}$," the fleet response plan (FRP) deployment percentage for squadron "s" in year "t" (the percentage of the year the squadron was deployed during fiscal year "t").

The regression model given in (1) also includes four variables that are measured in average number of months:

"**average_maintainer_time_in_unit**$_{st}$," "**average_maintainer_time_in_squadrons**$_{st}$," and "**average_maintainer_time_with_T/M/S**$_{sat}$" measure the experience levels of the maintainers in squadron "s" in year "t," including their average months of experience working with the T/M/S or T/M/Ss of aircraft flown by squadron "s" in year "t."

The "**average_age_of_aircraft**$_{sat}$" measures the average age of the aircraft of T/M/S_a in squadron "s" in year "t." Because these variables are measured in average terms, we think it is reasonable to assume as we do in equation (1) that a one-month increase in them will have very similar effects on the MSR across squadrons of different sizes (different numbers of aircraft and maintainers) and squadrons with different aircraft types.

$$\sum_{n=2005}^{2012} Indicator(\text{year} = n)_t$$

is the set of year-fixed effects (i.e., indicator variables for year) that we use to control for what fiscal year each record in the data is from. As stated in the main body of the text, controlling for fiscal year controls for Navy-wide changes over time in factors that may affect the MSR that we could not collect data on. Such factors include replacement part availability or changes in maintainer labor productivity per maintenance man-hour.

$$\sum_{x=1}^{41} Indicator(\text{T/M/S} = x)_{sa}$$

are fixed effects for the 41 different T/M/S of aircraft in our dataset (i.e., indicator variables for the $T/M/S_a$ of each group of aircraft within squadron "s" of the same T/M/S).

As explained in the main body of the text, including these fixed effects in the regression means that each T/M/S has its own unique "baseline" MSR, and changes in the number of maintainers, number of man-hours, average maintainer time in unit, and so forth, may cause the MSR to move away from this baseline level.

$$\sum_{x=1}^{41} Indicator(\text{T/M/S} = x)_{sa} \times \text{year}$$

are T/M/S-specific linear time trends: interactions of the fixed effects for the 41 different T/M/S of aircraft with the variable for fiscal year (which takes the values 2004 to 2012). Including the interactions between T/M/S and fiscal year means that the baseline MSR for each T/M/S is allowed to follow its own T/M/S-specific linear path over time. We found that the results of regressions that did not include these linear time trends were very similar to those that did include linear time trends, however.

"ε_{sat}" denotes the error term, or residual, of the regression.

In the regressions, we weighted each observation by the equipment in service (EIS) hours of the aircraft of $T/M/S_a$ for that squadron in that year. This means that squadrons with more aircraft and that have their aircraft available for more hours of service during the year are given more influence when the regressions calculate the regression coefficients B_1 through B_{103} that estimate the effects of the factors on the MSR. The estimates were very similar when we ran regressions that did not weight by EIS hours or any other variable, however.

The standard errors for our regression estimates are clustered at the squadron level. Clustering at the squadron level allows for both heteroscedasticity and arbitrary patterns of serial correlation in the error terms. In academic research, allowing for this is now common practice when regressions that include fixed effects are used. This is because clustering prevents the standard errors from being underestimated and thereby prevents the statistical significance of the estimates from being overstated [4].

Table 35 gives the results of our regressions (coefficients and the standard errors on the coefficients for the variables of interest, as well as the R-squared for the regressions).

Table 35. Regression estimates of effects of factors on the MSR

	Sample[a]				
Variable	Full sample	Years with NATEC current year data only	Years with NATEC previous year data only	Fixed-wing aircraft only	Rotary aircraft only
Percent change from average year	0.213437**	0.172111	0.171151	0.282213**	0.117850
in number of maintainer billets	[0.057762]	[0.107290]	[0.142025]	[0.077712]	[0.115495]
Percent change from average year	-0.147621*	-0.135938+	-0.176517+	-0.154268*	-0.130074
in number of maintainers	[0.056537]	[0.073491]	[0.099471]	[0.075924]	[0.091701]
Percent change from average year	0.025086+	0.028541	-0.001860	0.011027	0.050046*
in number of maintenance man-hours	[0.012741]	[0.024346]	[0.027461]	[0.016255]	[0.019032]
Percent change from average year	-0.056191**	-0.073542**	-0.060623*	-0.041603+	-0.075266**
in number of aircraft	[0.017754]	[0.021819]	[0.029614]	[0.024734]	[0.024380]
Percent change from average year	0.000397	-0.002313	-0.003759	-0.000711	0.000416

Table 35. Regression estimates of effects of factors on the MSR

Variable	Full sample	Years with NATEC current year data only	Years with NATEC previous year data only	Fixed-wing aircraft only	Rotary aircraft only
			Sample[a]		
in annual contract maintenance cost	[0.002513]	[0.006330]	[0.007450]	[0.005177]	[0.003291]
Percent change from average year		-0.014086*			
in NATEC hours		[0.006545]			
Percent change from average year			0.001579		
in hours of NATEC support last year			[0.008588]		
Maintenance personnel FIT rate	-0.057995	-0.036296	0.019724	-0.039666	-0.149801
	[0.057026]	[0.079286]	[0.091749]	[0.071148]	[0.101303]
FRP deploy percentage	0.051732*	0.031987	0.107407*	0.041763	0.055458
	[0.025368]	[0.033389]	[0.042478]	[0.026561]	[0.080070]
Average maintainer time in unit	0.003024+	0.004366	0.002688	0.007862**	0.000939
	[0.001717]	[0.003119]	[0.003661]	[0.002381]	[0.001838]
Average maintainer time in squadrons	0.000155+	-0.000059	0.000104	0.000118	-0.000034
	[0.000093]	[0.000352]	[0.000404]	[0.000191]	[0.000358]
Average maintainer time with T/M/S	-0.000086	-0.000572**	-0.000578*	0.000019	-0.000084
	[0.000127]	[0.000184]	[0.000227]	[0.000603]	[0.000128]
Average age of aircraft	-0.000712**	-0.000582*	-0.000643+	-0.000453*	-0.001541**
	[0.000196]	[0.000228]	[0.000334]	[0.000217]	[0.000546]
Year fixed effects included?	Yes	Yes	Yes	Yes	Yes
Aircraft T/M/S fixed effects?	Yes	Yes	Yes	Yes	Yes
T/M/S-specific linear time trends?	Yes	Yes	Yes	Yes	Yes
Observations	1,193	488	363	841	352
R-squared	0.41	0.46	0.44	0.40	0.45

a. Table notes: Standard errors are in brackets; standard errors are clustered at the squadron level; +means variables are significant at 10%; * means variables are significant at 5%; and ** means variables are significant at 1%.

The regression in the left-most column of table 35 was run using our full sample of data: data from all fiscal years (FY 2004–2012) and data from both squadrons with fixed-wing aircraft and squadrons with rotary aircraft (i.e., helicopters). Again, the variables for hours of NATEC support are not in this regression, because accurate data on NATEC hours are available only for FY 2009–2012. Variables for hours of NATEC support are included in the regressions whose results are shown in the second and third columns from the left in table 35, however. The regression in the second column includes the variable for NATEC hours in the current year, and so uses data from four fiscal years, FY 2009–2012. The regression in the third column includes the variable for hours of NATEC support in the year prior to the year that the data on the MSR and the other factors besides NATEC hours are from. This regression uses three fiscal years of data (FY 2009–2011 for NATEC, and FY 2010–2012 for the other variables).

The regression coefficient on the NATEC variable in the second column is actually negative and statistically significant. This suggests that reverse causality is indeed present: Squadrons tend to get more hours of NATEC support when the MSR is low, and the influence of this negative association between the MSR and NATEC support hours prevents us from detecting any positive effect that increasing NATEC support hours has on the MSR. The coefficient on the lagged NATEC hours variable in the third column is positive, but not statistically significant: Taking the lag may have alleviated reverse causality bias, but even with the lag we were still unable to detect an effect of increased hours of NATEC support on the MSR. As discussed in the main body of the text, this may be because NATEC is actually a very small program, with far fewer people and far fewer total man-hours per year across all of its staff than the number of maintainers who are assigned to squadrons and the number of maintenance man-hours that these maintainers work per year.

The data used to run the regression in the fourth column from the left in table 35 includes data on fixed-wing aircraft only. The regression results in the fifth column are from a regression that used data on rotary aircraft only. These regressions do not include either of the variables for hours of NATEC support, and as such we included data from all of the fiscal years covered in our data (FY 2004–2012) in these regressions. Subject matter experts that we spoke with for this project told us that the effects of the factors we examined on the MSR could vary between fixed-wing and rotary aircraft, so we ran these regressions in order to estimate whether there are differences between fixed-wing and rotary. The estimated effects of many of the factors, notably number of aircraft and aircraft age, are similar between fixed-wing and rotary. Our estimate from the full sample is driven by estimated effects of these factors on the MSR for fixed-wing aircraft—these factors appear to have less effect on rotary aircraft.

However, the variable for number of maintenance man-hours is estimated to have statistically significant effect on the MSR for rotary aircraft but not the MSR for fixed-wing aircraft. Maintenance man-hours is highly correlated with the number of maintainers though, which could have made it hard to detect the effects of these two variables in both the fixed-wing aircraft data and the rotary aircraft data. Further, in the data, maintenance man-hours are measured at the squadron-T/M/S-year level (i.e., the factor is measured differently for aircraft of different T/M/Ss within each squadron), whereas number of maintainers is measured only at the squadron-year level. Because rotary aircraft squadrons tend to have aircraft of more than one T/M/S within them and because it is possible for a squadron's maintainers to spend a disproportionate amount of time working on one T/M/S rather than another, it may be easier to detect an effect of man-hours on the MSR of rotary squadrons that it is to detect an effect of the number of maintainers and number of maintainer billets on the MSR of rotary squadrons.

Although we do not report the results of these regressions in table 35, we also ran a set of regressions in which each regression used data on aircraft of a specific squadron type only (e.g., data from strike fighter attack squadrons only, data from antisubmarine squadrons only, data from electronic attack squadrons only, etc.). We did this for the eight squadron types that contain the largest number of squadrons (antisubmarine, antisubmarine light, early warning, electronic attack, logistic support, maritime strike, sea combat, and strike fighter attack).

For the fixed-wing squadron types on this list (early warning, electronic attack, logistic support, and strike fighter attack), the regression results for each squadron type were mostly similar to those shown in the fourth column from the left in table 35. The results in that column are for the regression run with data on all types of fixed-wing aircraft, but no rotary aircraft. For the rotary squadron types on this list (antisubmarine, antisubmarine light, maritime strike, and sea combat), the results for each squadron type were mostly similar to those shown in the left-most column in table 35. The results in that column are for the regression run with data on all types of rotary aircraft, but no fixed-wing aircraft.

While these results were mostly similar, the coefficients were imprecisely estimated, and occasionally there were large differences in results between squadron types. For example, the coefficient on the "average maintainer time in squadrons" variable is nearly six times larger for strike fighters than it is for any other squadron type (the coefficient is 0.003425 and is statistically significant at the 1-percent level for strike fighters, whereas the coefficient is statistically insignificant for the other squadron types). The coefficient on the "number of maintainers" variable is positive for three out of the four fixed-wing squadron types, but negative for the other fixed-wing squadron type.

We ran separate regressions for each of these squadron types individually to determine the extent to which the regression results vary among squadron types. If we had obtained precise estimates of the effects of the factors in the regressions on the MSRs of squadrons of different types, and found moderately large differences between squadron types in these estimates, then we could have made recommendations about targeting available maintenance resources towards the squadron types that would make best use of them. For instance, if increases in the number of maintainers caused larger increases in the MSR for some squadron types than for others, then any future increases in the number of aircraft maintainers in the Navy could be targeted towards those squadron types.

However, in our view, finding very large differences in estimated effects—namely, results that are positive and statistically and/or practically significant for some squadron types but negative and statistically and/or practically significant for other types—would cast some doubt on whether we had obtained reasonably accurate estimates in our regressions that used data from every type of squadron (or every fixed-wing squadron type, or every rotary squadron type). This is because we do not believe the true effects on the MSR of an increase in a maintenance factor would differ in sign between squadron types. Given the small number of observations within each squadron type, however, and that there may be few differences between squadrons of the same type in the sizes of changes over time in the factors that could affect the MSR, we expected that there might be some large differences in estimated effects between squadron types simply due to sampling variability, rather than to omitted variable bias or measurement error.

Again, when we broke the regressions down by squadron type, we found that most of the results for fixed-wing squadron types were similar to our results from the regression using data from all fixed-wing aircraft, and that most of the results for rotary squadron types were similar to our results from the regression using data from all rotary aircraft. However, the coefficients in the regressions broken down by squadron type were imprecisely estimated, so we do not believe our estimates can be used to make recommendations about targeting available maintenance resources to the squadron types that would make best use of them. Further, there were even a small number of factors for which there were very large differences in estimated effects between squadron types.

As such, we think it would be beneficial to continue to explore the topic of estimating the effects of these maintenance factors on the MSR—and other maintenance outcome variables such as replacement parts costs—in future studies. Use of larger datasets, with more observations, as well as data on additional factors that could affect the MSR but that are not included in our study regressions, may allow us to obtain more precise estimates of the effects of maintenance factors on the MSR. For example, the regressions could include aircraft-specific fixed effects.

We think collection and analysis of larger datasets on aircraft maintenance are possible, and that this is a promising and important area for future research on managing the maintenance of Navy aircraft.

Appendix B: Naval Air Technical Data and Engineering Services Center (NATEC)

One of the two main research questions for this study was whether changing outside technical assistance support levels provided by NATEC was negatively affecting aircraft readiness. We conducted an in-depth review and headquarters site visit to assess NATEC's current impact upon squadron O-level maintenance.

Mission and charter

NATEC's stated mission is to:

> "Support combat effectiveness through the delivery of cost effective Engineering Technical Services (ETS) and Technical Data Products/Services to the Naval Aviation Enterprise." [5]

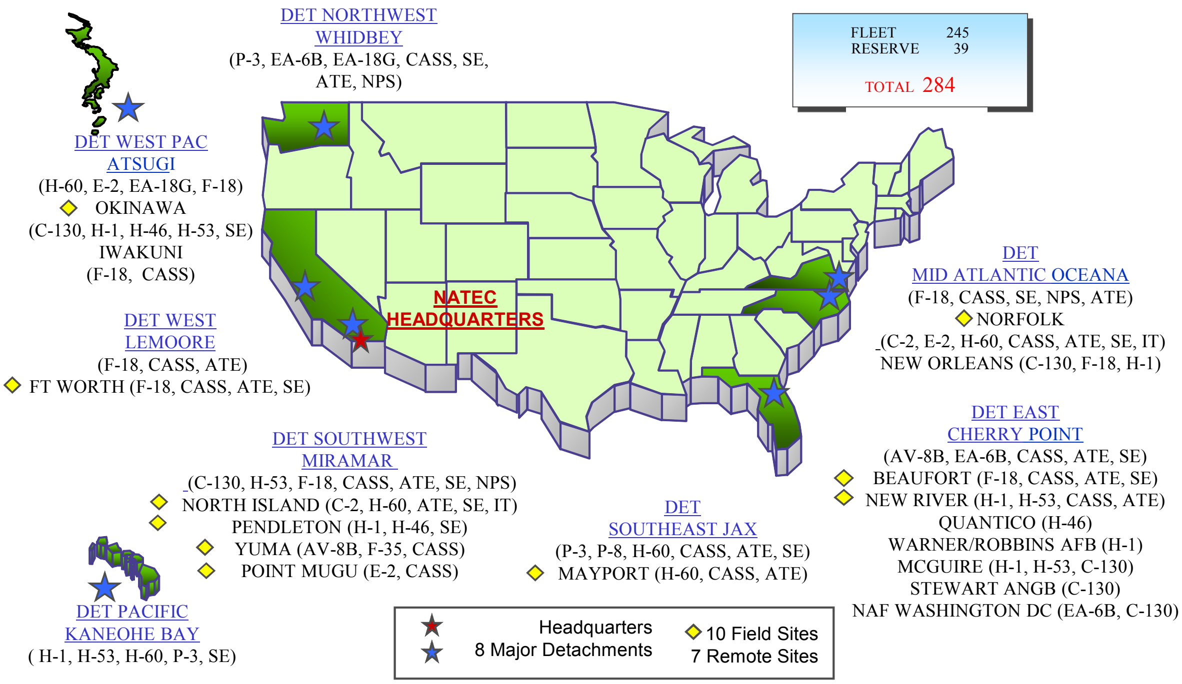
NATEC's funding and administration is under NAVAIR while the tasking is primarily through Commander, Naval Air Forces (CNAF) and fleet units.

Organization

NATEC headquarters is in San Diego, California, and has numerous field detachments in order to place technical expertise as close to fleet requirements as possible. Figure 93 provides a map of the office locations.

NATEC's total staff in FY 2013 was approximately 235 government and contractor technical representatives. This does not include administrative personnel. These technical representative are chartered under the Naval Aviation Maintenance Program (NAMP) [5] to provide aviation maintenance training, information, and assistance

Figure 93. NATEC office locations site map



throughout the naval aviation enterprise. Table 36 provides a summary of NATEC staffing since FY 2008.

Table 36. NATEC personnel staffing, FY 2008 to FY 2012

	Number of personnel (FTE)[a]						
	ETS[b]		Admin		Total		Grand total
FY	Civilian	Contractor	Civilian	Contractor	Civilian	Contractor	
2008	267	94	79	38	346	132	478
2009	253	86	83	32	336	118	454
2010	250	79	85	25	335	104	439
2011	247	61	76	26	323	87	410
2012	251	64	81	26	332	80	412
Change	-6.0%	-31.9%	2.5%	-31.6%	-4.0%	-39.4%	-13.8%
	-16	-30	2	-12	-14	-52	-66

a. Full-time equivalent (FTE)
b. Engineering and technical services (ETS)

Table 37 provides a summary of the grand total column from table 36.

Table 37. NATEC number of personnel, trend analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
478	439	410	-13.8%	-66	29	0.07

Services provided

NATEC's support to squadrons is documented in terms of the number of requests and manhours expended in response to requests for assistance(RFA), requests for training (RFT), and requests for information (RFI). NATEC's charter is to provide training, assistance, and information, but NATEC does not provide actual repairs. The goal of NATEC is to impart technical training to the sailor and increase the squadrons capability to maintain aircraft and systems in a detachment or deployment environment.

We focused on the NATEC ETS that provided responses to the 145 squadrons in our dataset. Figure 94 below shows the number of squadrons that NATEC supported from FY 2009 to 2012.

Figure 94. Navy squadrons receiving NATEC support

Squadrons receiving NATEC support

FY	VFA	VP	VAQ	VR	VAW	VQ	VFC	VPU	HSC	HSL	HSM	HS	HM	TOTAL
2009	32	14	15	10	10	1	2	2	10	5	4	5	2	112
2010	25	15	15	13	10	1	1	2	11	5	5	5	2	110
2011	21	15	15	13	10	1	1	2	13	5	7	5	2	110
2012	22	15	15	10	10	1	2	1	14	3	7	5	2	107
Change	-31.3%	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-50.0%	40.0%	-40.0%	75.0%	0.0%	0.0%	-4.5%
	-10	1	0	0	0	0	0	-1	4	-2	3	0	0	-5

Table 38 provides a summary of the total column from figure 94.

The table shows that the number of squadrons that receive NATEC ETS assistance has remained basically the same with a small drop in units supported. There were only five fewer squadrons (4.5 percent) over four years.

Table 38. Number of Navy squadrons receiving NATEC support, trend analysis

Maximum	Mean	Minimum	% change	Value change	SD	CV
112	110	107	-4.5%	-5	2	0.02

Figure 42 shows the increase in O-level technical support that has been achieved despite a reduction in personnel FTE available. Over the four years, NATEC was able to increase the number of support hours by 1,112 hours or 4.0 percent.

How squadrons obtain NATEC services

Often NATEC receives requests from the echelon II type commander, CNAF. This usually comes through the aircraft T/M/S class desk officer or the maintenance directorate. NATEC also receives calls from the type wing, fleet support teams (FSTs), or by direct phone call from the fleet. Since NATEC representatives spend time in and around squadron maintenance spaces, some requests are face-to-face from maintenance chiefs or work center supervisors. These requests are entered into the NATEC data system by NATEC personnel.

NATEC operates a website[16] where maintenance personnel can use a common access card (CAC) to register for a user name and password. In FY 2012, 36 percent of the requests received by NATEC came through the website. NATEC headquarters suggested that this number might be higher if it were easier for sailors and marines to keep track of the web address, user names and passwords. NATEC headquarters believes that most fleet personnel do not take the time to register or that if registered, they lose their account information. It is easier to rely on the NATEC representative to register the requests. NATEC would like a more accurate reflection of who is requesting their services. Requests for deployed and/or afloat assistance must come in the form of a naval message.

Figures 95 and 96 provide an overview of NATEC ETS support over the last five years.

16. The web address is http://www.mynatec.com

Figure 95. NATEC support by maintenance level

Requests for support by level			
FY	O-level	I-level	D-level
2008	74.3%	19.4%	0.3%
2009	73.4%	25.4%	1.2%
2010	68.4%	30.6%	1.0%
2011	69.6%	29.5%	0.9%
2012	70.4%	28.4%	1.2%
Change	-5.2%	46.4%	300.0%
	-3.9%	9.0%	0.9%

Figure 96. Types of NATEC requests over time

Requests for support by type			
FY	RFA	RFI	RFT
2008	71.0%	12.7%	9.2%
2009	71.0%	17.5%	10.7%
2010	60.0%	24.2%	14.4%
2011	60.0%	25.6%	14.4%
2012	64.2%	21.1%	14.7%
Change	-9.6%	66.1%	59.8%
	-6.8%	8.4%	5.5%

The annual requests for support by type do not add up to 100 percent for each year since an additional "other" category is not included with the information. NATEC has worked to improve their data capture and documentation, and each year the data quality has improved. It may be that some of the changes in more RFAs to more RFTs over time may be due to improved reporting as well as to an emphasis on training provided.

Although this study focused on Navy squadrons, NATEC also supports Marine Corps squadrons. NATEC headquarters told us that one-third of the support provided is requested from the USMC, but the data show that in FY 2012 NATEC provided closer to 40 percent of their support to the Marines. Figure 97 is the breakdown between Navy and Marine Corps support by both number of requests and man-hours applied.

Figure 97. NATEC breakdown of Navy and USMC support allocation

NATEC USMC Support Share		
FY	Requests	Man-hours
2008	32.8%	30.6%
2009	34.3%	35.3%
2010	34.7%	37.3%
2011	39.2%	38.5%
2012	39.8%	38.2%
Change	21.4%	24.9%
	7.0%	7.6%

The USMC demand signal for NATEC support has increased by 7 points or 21.4 percent over the past five years. The overall NATEC support allocation to the USMC has increased by 7.6 points or 24.9 percent. We looked at the aircraft inventory for both the Navy and Marine Corps; this is displayed in figure 98. The USMC share of total aircraft inventory has declined by 2.2 points or 6.9 percent in five years. Currently, NATEC financial accounting is not broken into separate lines for T/M/S of aircraft, location, or Service.

Figure 98. Navy and USMC aircraft inventory allocation

Naval aircraft inventory breakdown		
FY	Navy	USMC
2008	68.2%	31.8%
2009	69.0%	31.0%
2010	69.6%	30.4%
2011	70.2%	29.8%
2012	70.4%	29.6%
Change	3.2%	-6.9%
	2.2%	-2.2%

Based on the changes in aircraft inventory, it is clear that more of NATECs technical resources are being dedicated to the smaller USMC portion of the aircraft inventory over the past five years.

NATEC documents the training provided in some detail. We looked at the change in O-level RFTs by core capability or area. (The spike in the 2009 A/F number is due to a short-lived documentation policy.)

Figure 99. NATEC O-level number of RFT by system type

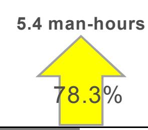
O-Level number of RFT by type									
FY	A/F	AV	ELEC	IT	LSR	P/P	TEST SUPPORT	UNDESIGNATED	TOTAL
2008	320	405	192	14	7	140	95	434	1,607
2009	1,183	905	494	15	0	185	133	241	3,156
2010	709	824	440	22	2	249	106	20	2,372
2011	552	725	397	23	2	290	105	12	2,106
2012	556	741	375	27	0	329	130	13	2,171
Change	73.8%	83.0%	95.3%	92.9%	-100.0%	135.0%	36.8%	-97.0%	35.1%
	236	336	183	13	-7	189	35	-421	564

The majority of requests for training involve airframes and avionics, but powerplants requests are growing. While figure 99 describes the types of training provided, we also looked at man-hours per training event.

The average number of man-hours dedicated to each RFT has grown 78.3 percent over the last five years; this is displayed below in figure 100.

Figure 100.NATEC O-level average FFT man-hours per request

O-Level Average RFT Man-hours per request	
FY	Man-hours
2008	6.9
2009	6.9
2010	10.9
2011	11.5
2012	12.3
Change	78.3%
	5.4



Max	12.3
Mean	9.7
Min	6.9

Contractor engineering and technical support (CETS) and other contractor support

NATEC, prior to FY 2004, was a larger organization. Chartered to provide the government technical expertise to deployed units, NATEC CETS representatives were typically the only civilians one would find afloat. NATEC provided contract vehicles for commercial technical representatives to be hired and deployed. NATEC's contractors, CETS, were contracted through NATEC to ensure contractual language, including "in-time" or "war mobility" agreements protecting both the government and the contractor during times of war. This portion of NATEC has changed radically over the last decade.

Today one can find any number of civilians in a military workspace, even afloat. The contractors in the fleet workspace come from multiple funding sources; acquisition program offices, system's command engineering and logistics directorates, manufacturers (during and post delivery), and the echelon IIs. There is not one data system or contractor office where all contractors are listed.

This large and invisible work force presents challenges in that without visibility into what is supported, NATEC cannot accurately target their scarce resources to support areas that do not have coverage.

There are two areas in the master data table, table 2, that refer to contractor support. The CETS section is in man-hours provided, and this support is found in table 36. The other contractor costs, from the OP-20, are costs that the flying hour program pays for organic support. Much of this pays for technicians and artisans in the fleet readiness centers to maintain engines for the squadrons, as well as support for fleet readiness squadrons. We've had several conversations with representatives from the Commander Naval Air Force, Pacific comptroller, OPNAV N43 and OPNAV N98. Contract costs are increasing but the data to further investigate this do not exist. Naval Aviation does not track executions at the squadron level, but at the wing or T/M/S level.

NATEC's impact on readiness

The impact of NATEC on a unit's readiness in not connected. Along with the regressions discussed earlier, we also manually pulled the integrated weapons system reviews (IWSR) events that NATEC provides squadrons prior to deployment. IWSR documentation has changed over time in the data, so these were not a useful link. Few squadrons that received NATEC IWSR events deployed within six months, and these just did not prove statistically significant.

The assistance and training that NATEC provides is usually linked to a work center or specific aircraft system. We believe that the only way to look at connecting NATEC provided support to output readiness results will be to perform analysis at the work unit code (WUC) level. Fortunately NATEC collects this information. Future analysis can use data in the DECKPLATE database, and compare the aviation systems availability, reliability, and maintainability before and after the NATEC event.

Price performance model

OPNAV N43 and OPNAV N98 asked CNA, while conducting this study, to look at the available data to determine if there is enough data to create a performance pricing model for the account that funds NATEC. The need for a performance pricing model is driven by current policy [6] that each account of $50 million or more must have a performance pricing model, or a waiver. The NATEC account is $45 million in FY 2013. NATEC has two halves, the engineering and technical services, and the data warehousing and repository side. For the purposes of this study, we looked at just the engineering and technical services.

A successful performance pricing model requires a high fidelity of data over a lengthy period of time, and at a minimum needs to contain data on the requirement, the demand for the requirement, execution, and the output as it links to readiness. We found that NATEC's data collection system, ETS local assist request version 2 (ELAR II), is sufficient to provide the necessary data elements of a model, and should have accumulated five years of comprehensive data at the

EOFY 2014. The specific elements of NATEC's ELAR II data capture are listed in table 39. However, we could not find a user's manual for the ELAR II system. A Navy user manual should be developed.

NATEC began capturing detailed workload information in FY 2008 with the newly developed ELAR II management system. Table 39 provides a reference listing of the fields included within the database and brief descriptions of each field's contents, where necessary.

Table 39. NATEC ELAR II management system data elements

Field	Description
Customer Name	
Designation	Civ, Civ/Gov, Contractor, Military Ranks (E1–010, FMS)
Primary Phone	
Pri Ph Type	CELL, COM, DSN, FAX, INTL
Squadron/Activity+	Support Requesting Activity
Activity UIC+	Support Requesting Activity
Request ID+	Unique Remedy ID
Customer Email+	
Secondary Phone	
Sec Ph Type	CELL, COM, DSN, FAX, INTL
Program	Aircraft / Support Program
Model	Model of Aircraft / Support Program
System	Numeric System Level
WUC+	5 to 7 alphanumeric WUC
Nomenclature+	
O/I/D	
JCN	Job Control Number
Method of Request	How was the support requirement received; Phone, email, web, naval message, etc.
Type of Request	RFA, RFI, RFT
Category	DS Support Category Identification
Subject	Subject of Support Request
BUNO / SERNO	
Aircraft/Equipment Status	Status of Aircraft/Equipment at time of support commencement
Description	Expanded description of support requirement
Support Location	FSI specific designation
Assigned Group	Detachment

Table 39. NATEC ELAR II management system data elements

Field	Description
Assigned Individual	Tech Rep
Core Discipline	Core Discipline of Assigned Individual
Action Taken	Menu selection of Action Taken on Support Requirement. All ELARS
Training Recommended	Training Recommendation by Tech Rep for RFA support
Core Discipline Supported	RFA & RFI
Create Date	Date/Time Support Request was Submitted
Support Request Status	New, Assigned, Work in Progress, Long Term issue, Resolved Closed
Est Complete Date	Used on Long Term Issues
Hold Reason	Reason for Long Term Issue status
Job Start Date	
Job Complete Date	
Man-hours applied	
Total Man-Hours	Calculated Field of Travel Time & Man-hours; include Child Values
OJT Conducted	Yes/No
Type of Support Provided:	Distance Support, DS Transition to Off-site, Local Support
Did this result in Travel Orders?	Yes/No
Travel Time - Orders	
DTS Travel Cost	
Resolution of Final Support	
Training Start Date	
Training End Date	
# of Students	
Length of Training	
Instructor Prep Time	
Type of Training	Formal / OJT
Core Discipline - Training	RFT
Action Taken	Menu selection of Action Taken on Support Requirement. All ELARS
Modified Date	Date/Time Support Request was last updated.
Fleet/Reserve	Funding status of Assigned Individual
NETS/CETS	NET/CET of Assigned Individual
Task	Task Number of Assigned Individual
TechAssist Message DTG	Message DTG requesting Tech Assist
Action Message DTG	NATEC Response/confirmation
Funding	Funding designation for Tech Assists

Table 39. NATEC ELAR II management system data elements

Field	Description
Support Location	FSI specific designation
Site Specific ID (Optional)	FSI specific designation
Requested Start Date	Tech Assist Message Requested
Requested Complete Date	Tech Assist Message Requested
Notes Entry / Notes	FSI Note Space
Assist Location	Identifies Shipboard/Ashore based upon Support Location
P/C	Display Column: P= Parent / C= Child
Parent ELAR	Request ID of Parent ELAR
NATEC Location	Geographic location of Det
New Time	System Generated History Time
Assigned Time	System Generated History Time
WIP Time	System Generated History Time
LTI Time	System Generated History Time
Resolved Time	System Generated History Time
Closed Time	System Generated History Time
Cancel Time	System Generated History Time
Transferred Time	System Generated History Time
Re-Open Time	System Generated History Time
Submitter	User submitting ELAR

NATEC summary of findings

In our review of NATEC operations, we determined that the organization provides a valuable service to the fleet; however, it is not the most significant driver of aircraft MSRs. Nor has the level of support to the squadrons decreased.

We did identify several areas and actions that could be pursued by the Navy which would improve the effectiveness of NATEC fleet support and increase their positive influence on aircraft MSRs. We included these six suggested actions along with our other recommendations in our conclusion section.

Glossary

AD	aviation machinist's mate
AE	aviation electrician's mate
AFM	aviation fleet maintenance
AIRRS	Aircraft Inventory and Readiness Reporting System
AM	aviation mechanic
AME	aviation structural mechanic, safety equipment
AN	airman
AO	aviation ordnanceman
AT	aviation electronics technician
AVDLR	aviation depot level repairable
CAC	common access card
CETS	Contractor engineering and technical support
CNAF	Commander Naval Air Forces
CV	coefficient of variability
DECKPLATE	Decision Knowledge Programming for Logistics Analysis and Technical Evaluation
EIS	equipment in service
ELAR II	ETS Local Assistance Request system, version 2
EOFY	end of fiscal year

ETS	Engineering Technical Services
FLMP	Fatigue Life Management Program
FRP	fleet response plan
FST	Fleet support team
FTE	full-time equivalent
FY	fiscal year
HM	helicopter mine countermeasures squadron
HS	helicopter antisubmarine squadron
HSC	helicopter sea combat squadron
HSL	helicopter antisubmarine light squadron
HSM	helicopter maritime strike squadron
IWSR	Integrated weapons system reviews
MSR	maintenance support rate
NAMP	Naval aviation maintenance program
NAS	Naval Air Station
NATEC	Naval Air Technical Data and Engineering Service Command
NAVAIR	Naval Air Systems Command
NEC	Navy enlisted classifications
NMCM	not mission capable due to maintenance
O-level	organizational level
PMCM	partially mission capable due to maintenance
PR	aircrew survival equipmentman

RBA	ready basic aircraft
RFA	request for assistance
RFI	request for information
RFT	request for training
RFT	ready for tasking
SD	standard deviation
SNDL	Standard Naval Distribution List
TFMMS	Total Force Manpower Management System
T/M/S	aircraft type, model, series
UIC	unit indentification code
USMC	United States Marine Corps
VAQ	fixed-wing electronic attack squadron
VAW	fixed-wing early warning squadron
VFA	fixed-wing strike fighter attack squadron
VFC	fixed-wing fighter composite squadron
VP	fixed-wing patrol squadron
VPU	fixed-wing special project squadron
VR/VRC	fixed-wing fleet logistics support squadron
VQ	fixed-wing reconnaissance squadron
WUC	work unit code

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